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The Journal of Radiology appears for the first time with this issue.

The Journal in reality is not something entirely new. It is hoped, however, that it will be possible to present many new features for the further development of Radiology.

The intention of the Journal is to serve the entire medical profession, inasmuch as it is intended to treat *x*-ray, radium and electricity from every possible angle of diagnosis and therapy, thereby correlating more or less the various phases of diagnosis and treatment.

The Journal will be owned, controlled and published exclusively by the members of the Radiological Society of North America.

The Journal of Radiology earnestly solicits the coöperation of the entire medical profession, as the progress of this science necessarily concerns each and every medical individual.

We do not wish to feature Radiology as an individual branch of medicine, but only as an indispensable essential to the collective phases.

RADIUM AND ROENGTEN TREATMENT IN MALIGNANCY

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The reason for incompetent therapy is that many are just beginning to use radium and in so many places the roentgen rays are employed by inexperienced operators. While radiotherapy is not a new subject it is new to many, and for some reason or other it seems to be a difficult subject to master. Of course some are taking up this line of work without any, or with very little, preparatory study of either agent or malignancy itself. A comprehensive study of malignancy is essential to either surgeon or radio-therapeutist before he treats malignant growths. He should know the origin of the growth, its type, duration and mode of extension, also the cause of death, in order to give the patient the greatest amount of palliation in hopeless cases. A good surgeon very often does very poor work in this line just the same as a good roentgenologist along other lines does very poor therapy.

It is true that a large percentage of malignant cases are not treated intelligently either surgically or radiotherapeutically. Today many are giving radiotherapy as a placebo when real treatment is needed, and many are operating on cases past the borderline where surgery is contraindicated, making their patients worse instead of even giving palliation. The treatment of malignancy is really a specialty in itself, at least from the clinical and consultant side. A surgeon may be able to operate after consulting with some one who has had clinical experience, the same as a radiotherapeutist may be able to give the treatment after con-

sulting with some one of experience; in fact, the treatment of malignancy is a side issue with most surgeons and radiotherapeutists. Many of them know very little about metastases and a large proportion do not know whether operation is indicated or not. This is shown by the number of recurrences following early operations and the futile attempt to remove borderline and advanced cases. Some surgeons and roentgenologists who have better judgment are realizing this fact. Inefficient treatment has so often led to a fatal ending that no one inexperienced should employ any method of treatment for even the smallest lesion, no difference whether it is a superficial epithelioma, a tumor of the breast or ulceration of the cervix.

It is a well known fact that cutting out the center of a malignant growth is poor surgery, the same as radiotherapy is useless in the treatment of a local lesion, omitting the lymphatic chains which have metastasized. Eradicating every malignant cell is always a difficult problem by any method. Most radiologists as well as most surgeons are satisfied with the removal of the visible part of the disease, thereby losing valuable time and often allowing a patient to pass from a curable into an incurable state. In fact, too many have been satisfied with their own method of treatment. We have not found the real cure for cancer, but really the only step in advance during the last quarter of a century has been radium and the roentgen rays. Ultra radical operations for recurrences are seldom ever indicated. Raying should be done in order to stop cancer cell proliferation, and if all the cancer cells cannot be eradicated by radiation, then the remaining latent cancer tissues should be removed surgically or by electric-coagulation. In such cases, treatment of the lymphatics is very important and must be done by large quantities of radium or heavy filtered rays with the proper amount of crossfiring.

Those treating malignancy might be divided into three classes; viz, those who treat the local lesion or growth poorly; those who treat the local lesion properly, but omit

or have treated carelessly the metastatic glands; and those who treat the local growth properly but see that the adjacent lymphatics receive the most efficient radiation possible. There are comparatively few in the latter class. Even some surgeons of reputation after operation will send the patient home with a letter to the family physician stating that the patient should receive a Coolidge *x*-ray treatment over the line of incision once a month for six months, omitting so many lymphatics which in most cases contain cancer cells or will later metastasize. Such treatment is not only useless but there is danger of a roentgen dermatitis occurring by offering such poor advice. This is a daily occurrence. But whose fault is it for such bungling roentgen work? It is because so many give such treatment, and it is incumbent upon us, not the surgeon, to advise the proper radiation. If every one were as careful about his technic as the surgeon is with his aseptic precaution before, during and after operations, the end results in malignancy would be different. The treatment of a local growth depends on the nature and situation of the lesion as well as its stage.

Metastases and the lymphatics have been more thoroughly understood in late years as the result of investigations of Hanley. He studied the process particularly in connection with cancer of the breast, but the conclusions arrived at may be referred to other organs as well. In studying the method of cancer cells spreading to the lymphatic glands, the normal physiological relationship of the affected organ to the lymphatic system must be remembered. It has been demonstrated that the lymphatic vessels arising in tissue are not all intercepted by the nearest group of glands; the first set may be not invaded and the cancer cells enter the glands of a more distant group. It cannot be said positively of any malignant growth, however early, that it has not yet produced metastases in the glands. This fact has a most important bearing on the treatment of carcinoma. Therefore, the importance of the exact knowledge of the distribution of the lymphatic vessels and glands cannot be

overestimated. We have no means of determining the limitations of metastases and the extent of invasion of the lymphatic vessels. In practice, we must regard every case of cancer as one in which the lymphatic glands may be affected and give radium and roentgen treatment accordingly.

While it is, therefore, universally conceded that either radium or the roentgen rays is the method of choice in the treatment of epithelioma, yet radium has certain advantages, one being that radium can be inserted into the diseased tissue. Superficial epithelioma of the upper part of the face, before it involves cartilage or bone, is very amenable to radiation, but when the tissues are infiltrated it is more difficult to secure healing which will be permanent. When an epithelioma is situated on the mucous membrane it is more resistant to treatment and the glandular tissue is invaded early. If caustics have been employed, the cartilage is usually involved and it is much more resistant to treatment, and recurrence is more likely. Then, radiation to be successful must be thorough, and it requires more intensive radiation. Here, inserting radium needles is very valuable. When a case is clinically cured, unless the scar is smooth and pliable, there will nearly always be a recurrence. In these cases more radiation must be given or else the unhealthy scar be removed by some other method.

When epithelioma of the lower lip, both early and late, are treated thoroughly by radiation, the treatment including both sides of the neck, equal or better results are obtained than by extirpation. Epithelioma of the lower lip is a serious condition, and radiation, when employed, must be given in such a manner as to destroy all cancer cells in the local lesion and the adjacent lymphatics. When so given, over 90 per cent of the early cases should be cured without producing any deformity, more advanced cases are cured and the hopeless cases receive more palliation than by any other method.

The objection to surgical removal is the frequent recur-

rence in the scar, because the operation on the glands cannot be sufficiently complete, no matter how thoroughly the dissection has been carried out. The removal of the submental, part of the parotid, submaxillary and all the glands which metastasize together with the ligation and excision of the jugular is no easy task; besides cancer cells are often left in deeper glands which cannot be reached. This may seem very radical to those who do not know what has been accomplished by radiotherapy and likewise to those who are not familiar with results in early surgical removal, even when radically performed. It has been shown that a recurrence takes place in over 50 per cent of the cases in which there are no palpable glands at the time of operation, and in over 75 per cent in which there is any glandular involvement whatever.

The results of radium therapy of buccal lingual and pharyngeal cancer are ofttimes brilliant and other times disappointing. Experience warrants the consideration of radium in every case, whether alone in small lesions, as an anti-operative procedure or as a palliative method in hopeless cases. Since the smallest lesions are so prone to recur locally and the adjacent glands so early invaded, radiotherapy should follow even the excision of the smallest growth. In malignant growths in the mouth and throat, the writer has found that the best end results are produced when caustic doses of radium are used with radiation of the lymphatic glands to be followed by electric coagulation of the local lesion. The advantages of electric coagulation are the destruction of tissue without opening the blood and lymph vessels, and the prevention of dissemination which might occur with a cutting operation. The large amount of carcinomatous tissue which can be destroyed by electric coagulation without hemorrhage is an item of great importance, and compels serious consideration by those who have treated many malignant cases. Burying radium needles in lesions of the mouth and throat is a very valuable method of treatment and lately I have had curved needles made for this purpose.

Percentage of cures of cancer of the cervix by operation are disappointingly low, while the results by operation in carcinoma of the fundus are very good. During the last few years it has been realized that cures by the standard hysterectomy are comparatively few and that the high mortality restricts the usefulness of the Wertheim or radical operation. It has been stated that not more than 15 per cent of the cases of cancer of the cervix come early enough to be benefited by the standard operation; that is, before induration of the broad ligaments or extension of the disease into the pelvic glands has taken place, and in only sixty to seventy-five per cent it is justifiable to do a radical operation. When these facts are considered and since radium has become of such service both as a curative and palliative agent, we must pay more attention to this branch of therapy, because there will be only a very few gynaecologists give the subject sufficient attention to do competent work. A review of the literature will show that the most efficient treatment is not being given. The radium work done by the different operators might be compared to a standard hysterectomy where only early cases are cured by local application of a small amount of radium, and to the radical operation where more advanced cases are cured, not only by treating the local growth, but the abdominal and pelvic glands, by large quantities of radium or by from twenty-five to fifty *x*-ray treatments. A radium plaque containing a few radium tubes placed over the lower abdomen or three or four roentgen exposures is certainly very incompetent treatment.

Extension of the cancer cells into the perametrium and pelvic lymphatics from uterine carcinoma has been studied by many and in giving a prognosis as well as in giving the treatment, the importance of cancer dissemination must not be overlooked. Recent studies have shown there is no dependable relation between the size of the primary growth and the presence or absence of metastases. It has been stated that in forty per cent of inoperable carcinoma of the

cervix the pelvic nodes are free from metastases. This would account for some of the brilliant results, because even local radium treatment properly given appears to destroy cancer cells at a greater distance than can be reached surgically. Janeway states: "Our present evidence indicates that radium destroys the disease at a greater distance than the knife is capable of removing it, and does this with no risk or inconvenience to the patient." Kelley states: "Recent studies have shown that in from thirty to fifty per cent of operative cases of cancer of the uterine cervix the disease has formed metastases into the pelvic nodes." Similar statements have been made by other surgeons. Since it is the general opinion that the removal of the pelvic lymph nodes has very little curative value, we should develope an efficient method of radiating the lymphatics. Unfortunately, we are unable by any clinical test to determine whether or not there is an extension into the pelvic lymphatics. Therefore, the only safe procedure is to ray the pelvic glands in all cases of the stage of the disease.

Radium is indicated as a palliative measure for hopeless inoperable and recurrent cases, for operable cases when operation is contra-indicated and prophylaxis after surgical removal. Lately radium is being used by some for primary cases in carcinoma of the cervix when the disease extends into the cervical canal, because nearly all these cases are followed by recurrence, even in the early cases. These cases can be promptly cured by radium, and time alone will tell whether radium alone, without operation, is advisable.

Radium is a specific palliative in inoperable cancer of the uterus. It will clinically cure about one-third of the cases and subjective improvement is noticed in a certain percentage of the others. However, recurrence takes place in many of these clinically cured cases within two or three years. The patient during this time regains normal health and can lead a useful life. If a recurrence takes place, as a rule the patient suffers little in comparison with those who had no radium treatment. In these hopeless cases, the of-

fensive discharge and hemorrhage usually completely disappears within from two to four weeks. The cessation of discharge, which often is so offensive to the family and even to the patient, is a remarkable feature. The local condition changes in character within from two to four weeks after the treatment; the mass begins to contract and shrink, and continues to decrease in size. This is more marked in some cases than in others, the growth having entirely disappeared within two months. Today most surgeons consider the operation incomplete, except in the very early cases.

The prognosis and treatment of cancer of the breast is difficult. The questions arising are mainly three: If the growth disease runs a natural course, how long will the patient live? After removal surgically, what is the chance of recurrence? How many more cases can be cured by employing radium or the roentgen rays as an antioperative or post-operative procedure, and how much palliation can be given by competent radiation in inoperable cases? Without treatment the natural course of the growth depends on whether it is of the medullary or schirrus form. The former will usually terminate in a few months, while the schirrus cancer develops slowly and the expectation of life is at least from two to four years. A prognosis of non-recurrence after operation depends on the stage of development as well as the form of tumor at the time of operation. Today many are operating on advanced cases and expect the same results that the leading authorities claim in early cases. Except in the very early cases where the disease is localized in the breast, the outlook is hopeless as far as the end results are concerned, and today it is a question whether operation does not hasten rather than retard the process when a cure cannot be obtained surgically.

The surgical opinion is that, with a small localized mass in the breast, the patient can be assured that a cure can be expected in four out of five cases; that is, when there is a microscopic freedom of cancer cells found in the adjacent

lymphatics. When the adjacent lymphatics are found to contain cancer cells microscopically, the chances of a cure are at once diminished to one in five. When you state that cancer is found only by the microscope, that is an entirely different proposition from the cases where the axillary glands are palpably enlarged from metastases, because in the latter case the cancer growing edge is away beyond the reach of the knife. Until this is universally recognized by both the surgeon and radiotherapeutist and the patients are treated accordingly the highest percentage of cures will not be obtained or the greatest amount of palliation will not be given to the patient. When the cancer growing edge has reached beyond the surgical mark the patient may be cured by anti-operative radiation. Halstead found death from metastases in 32.4 per cent of the cases even with a microscopically negative axilla. This should be sufficient to show every radiotherapeutist how incompetent a few treatments over the line of incision, axilla and supra-clavicular glands are, and to show the surgeon that they cannot expect a cure surgically when the cancer growing edge is beyond the reach of the knife. Therefore, in anything except the very early cases radiotherapy is the most important part of the treatment. It has taken a long time for both to realize this fact. It is also realized that our present day therapy as it is generally given has only a slight palliative effect, and until better therapy is done the best end results will not be obtained. At least twenty per cent of the cases that reach the three year limit die later of recurrence.

It is difficult to determine the real value of anti- or post-operative radiation because so much of the work has been done in such an incompetent manner and there is no way to visualize or palpate all of the metastases at the time of operation. But it is beyond dispute that a patient is in better shape for operation after cell proliferation is checked by radiation and that many recurrences are prevented by competent radium or roentgen treatment after operation. The marked palliation in hopeless and recurrent cases is

appreciated by everyone. Therefore, radiation has taken a very important place in the treatment of carcinoma of the breast, and we should see that more competent work is done. The cancer-bearing area or microscopic edge of cancer of the breast is often from one and one-half to two feet extending from neck downward. It must be remembered that there are twenty or more lymphatic chains connected with the breast which will later metastasize if the cancer cells have not all been eradicated.

In an article published, "The Post-Roentgen Treatment of Carcinoma of the Breast", read before the American Roentgen Ray Society, New York City, September 22, 1917, I described the areas or lymphatics which should receive treatment together with the technic used at that time. At present slightly more skin areas are employed and in many cases six and ten millimeters of aluminum are used instead of four and the axillary and sub-clavicular glands are treated with a number of radium tubes, the reason for which will be described later.

The technic in the treatment of malignancy is far from being perfect. We have been trying to develop a method by which all cancer cells can be eradicated in every case. Such is hardly possible, but there still remains much to be done. Each year we are treating successfully cases which did not respond to our former treatment. Improvements in methods have made treatment of every type of malignancy, ranging from a superficial epithelioma to carcinoma of the breast or uterus, more efficient.

It is indeed much more rare to see a roentgen ulcer produced than was when everyone who had a machine treated epitheliomas. But we do see many cases of epithelioma, particularly of the mouth and throat, which have been treated in a careless manner either radiotherapeutically or surgically, thereby losing valuable time and often tissue changes taking place which makes further treatment useless. It must be remembered that normal tissue will stand just so much radiation and it can be repeated only a few

times. The following case will illustrate: A patient had carcinoma of the throat and was treated externally by roentgen rays by two different operators, each claiming to have given a full erythema dose within two weeks and no treatment was given to the local growth. So when he came under my care, I could not safely treat the glands of the neck. Only the local lesion in the throat was treated which disappeared within four weeks, but while I was waiting for a severe reaction from the *x*-ray treatment, a gland enlarged at the angle of the jaw. These two *x*-ray treatments were inefficient because no reaction appeared and the hair was not removed.

Burying radium and the proper use of electric coagulation have changed the results in cancer of the mouth and throat; but the question arises, should either be done until the lymphatics of the neck be treated by surface applications of radium to check cell proliferation. It is a question whether the deep glands containing metastastic cancer are sufficiently influenced by the ordinary roentgen rays or radium treatment and by the usual amount of crossfiring. It is true that it requires a large amount of radiation to cause the disappearance of all cancer cells even in the lymphatic glands, rather superficially situated in the neck or axilla. The treatment ordinarily given will stop cell proliferation but, if the glands are removed and examined, a latent cancer is found.

By using ten millimeters of aluminum and by using the highest possible penetration, superficial nodules will disappear that are only reduced in size under ordinary treatment. The same is true by using a number of radium tubes so placed as to give rather homogeneous radiation, as the radiation comes from many points instead of a focal point as it does with a roentgen tube. This is a method of crossfiring and is useful in treating glands in the neck and under the clavicle where crossfiring from a single focal point is difficult. There is less loss from absorption from a filtered radium pack than there is from our present day Coolidge

tube. The treatment of the lymphatic glands which are known to metastasize is a difficult task and one which has not received sufficient attention. It has become generally recognized that it requires more radiation to destroy cancer cells than it does to destroy sarcomatous tissue and that squamous carcinoma is not affected by the same amount that will destroy basal cell carcinoma.

X-RAY TREATMENT OF MALIGNANT GROWTHS

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Recent correspondence by the author with leading radio-therapeutists throughout the United States has shown such a wide variety of technic in use in deep therapy treatment that it is the desire of the author to try to standardize the technique for this kind of treatment. Out of the replies which have been received, only three men are using as heavy filtration and as high voltage as the author. We shall take up the matter of technique in detail later in the body of the paper, using the correspondence mentioned above, together with the experience of the author as a foundation for the conclusions.

The prevalence of malignant growths in the United States seems to be on the increase. Whether this increase is real or apparent is doubtful in my mind. There is a chance for a legitimate increase in the percentage due to the fact that the profession is making a more earnest endeavor to make an early and correct diagnosis in malignant diseases and also to the fact that the laity is being educated by wide-spread propaganda to the importance of going to the physician early in the case of new growths. Whether this increase is real or apparent, it calls to our attention the importance of the treatment of these conditions so that the utmost skill of the medical profession should be marshalled to combat this scourge.

The fact that malignant growths are as a rule well nourished, makes their destruction more difficult than it would otherwise be; especially when one is using physical means to combat them should this fact be borne in mind constantly. Due to the vascularity of malignant growths there are large

clusters of cells lying between the branches of the arteries which are practically surrounded by circulating blood. These cell nests, as ably demonstrated under the microscope by Holding and others, are the last part of the new growth to die. These cell nests are so small that they cannot be seen by the naked eye. Even when the new growths appear entirely healed on the surface, as long as these nests remain unkilled, we will have a recurrence just as certainly as night succeeds the day.

Roughly speaking then, new growths are made up of a vascular structure around which is superimposed the parenchyma. Due to this structural composition of the new growth it is especially vulnerable to the action of radium and *x*-ray. The histological action of both of these agents where proper technique is used, is the same. Both result first, in the destruction of the cell nucleus, producing a cloudy swelling in the nucleus and rupturing of the nuclear membrane with loss of the identity of the nucleus and cloudy swelling of the entire cell, followed by disintegration of the cell itself. These dead cells are probably carried away by the action of the phagocytes and are excreted from the blood through the urine. In cases following massive radio-therapy, it is probably this heavy load of proteid material thrown into the circulation which produces the acidosis called to our attention a number of years ago by Sidney Lange.

In addition to this action of the *x*-ray and radium upon the cell structures of the new growth, we have another action upon the vascular structure of the new growth. This is manifested most noticeably in the small arterioles. The action is noted by an intense swelling of the endothelial lining of the arterioles so that the lumen of the vessel is much reduced in size and in the case of the terminal arterioles the lumen is entirely obliterated, resulting in an endarteritis obliterans. It is well for us to have these histological actions of radio-therapy so indelibly printed on our memories that when treating a case we can visualize the picture.

Since the above action of the x-ray and radium has been definitely proven by the microscope and since we know the structure of the new growth to be as outlined above, there are certain fundamental principles which we can lay down and to which we must adhere in the treatment of these enemies of the human mechanism. One of these principles is that we must kill the growth or it will kill the patient. This is an immutable law and there are no exceptions. This rule will hold no matter whether we are using radio-therapy, surgery, chemical caustics or what not.

Since this paper has to do chiefly with the radio-therapeutic treatment of malignant growths, let us lay down another fundamental rule to be followed when this therapeutic means is employed. That is, we should administer the dosage which experience has proven will kill the growth and then for safety sake add as much more. This massive dosage is justifiable in the treatment of malignant growths but is not justifiable in the treatment of benign conditions. So far as I am able to gain information from the experience of radium-therapeutists and from my own personal observation, it is really this massive dose technique which has given radium its success. Many times I have had radium therapeutists tell me that they always produce a burn in the treatment of malignant growths but that this burn heals quickly.

This brings us to the discussion of the proper technique for deep roentgen therapy. I feel that we can learn a lesson from the radium therapeutists in giving massive doses of highly filtered rays. Every physician who has studied the question of technique in roentgen therapy of malignant growths has admired the results obtained by Pfahler of Philadelphia. A number of years ago I became an ardent admirer of him and learned from him the technique which he was employing. At that time I was failing in a percentage of cases in which I thought success ought to be obtained. I immediately went home and taking those same patients applied the technique followed by Pfahler and suc-

ceeded in getting these patients entirely well. This practical demonstration of the value of the highly filtered rays accompanied by high voltage so impressed me that I have never deviated from it since that time in treating malignant new growths.

It is interesting to note the letters I have received from different men throughout the country and with the exception of three none of them are using real deep therapy technique as I understand it. In fact, when I read a paper before this same society in November of 1918, several men came to me afterward telling me that I could get the same result by using a seven inch spark gap and a 3 millimeter filter. My only answer to that kind of an argument is that experience has not proven this to be true in my case. I have been using as a routine all of the voltage which the Coolidge tube would carry, never using less than 95 kilovolts and when possible going up closer to 110 than to 95. I have been using a parallel spark gap on my treatment transformer and during the entire treatment keep the spark just spitting across 9¾ inches of air space. I am living in a rather dry climate so I am getting more voltage with a 9¾ inch spark gap than one would get in a damp climate with the same spark gap, due to the fact that dry air has greater resistance to the passage of electricity than does moist air. Up to the present time I have been using a treatment machine equipped with a rheostat control. When one is using a treatment machine equipped with an auto transformer control, one can keep the voltage reading constantly at a certain point without using the parallel spark gap. Along with this high voltage I have been using 6 millimeters of aluminum and sole leather as filters. I have been using as a routine, 5 milliamperes of current at an 8 inch anode skin distance. Measure by Hampson's radiometer—using this technique it requires 5 minutes to give a pastille dose with the pastille resting on the skin underneath all of the filters. When I am treating malignant new growths I do not stop at the pastille dose but as a routine use three

times the pastille dose or 75 milliampere minutes with the technique described above. In extensive diseases where there is considerable vascularity and the condition points toward the fact that we should get as quick an action as possible, I even give as high as 225 milliampere minutes or 9 times the pastille dose over the same area. Of course I do not advise this extreme dosage without caution because this produces a burn. The reaction from it is tremendous but when the growth is located in the soft tissues near the surface, so that ulceration will do no harm, I employ it. I also employ this maximum dosage in the treatment of sarcoma. The burn produced by this treatment heals very quickly and looks and acts like the burn produced by radium. Practically speaking, I think this technique and dosage has the same clinical effect as radium treatment. I have a statement from Hirsch of New York who is using only a 4 millimeter filter and a 9 inch parallel spark gap at sea level. He claims that by measuring the amount of rays passing through 4 millimeters of aluminum by means of a Christen meter he finds there is little advantage gained by the additional 2 millimeters of aluminum. Arthur F. Holding did considerable experimental work during the years 1912–17, relative to the value of different thickness of filters, using the photographic effects of the ray upon sensitive plates. His report shows little difference in the photographic effects of the ray when passed through 4 millimeters of aluminum or when passed through 6 millimeters of aluminum. Even though this test on the photographic plate shows little difference when 4 or 6 millimeters of aluminum filter is used in my hands, as well as in the hands of Pfahler, Boggs and Ballard, the clinical effect on the patient is considerably different. There is more caustic action on the skin with the same dosage using 4 millimeters filter than when using 5 millimeters filter. The growth does not seem to melt down as fast under the thinner filter as under the thicker filter and high voltage. The skin recovers more quickly when the heavy filter and high voltage are used

than when the thin filter is used. Of course the better effects may be due to the high voltage used rather than to the amount of filter employed. I am convinced that both elements together with the massive dosage are responsible for my results.

I append herewith two case reports, one of a patient sufferly from hopelessly inoperable sarcoma and the other of a patient suffering from hopelessly inoperable carcinoma. In both of these patients the high voltage, 100–105 kilo-volts, and 6 millimeters of aluminum and sole leather filters were used. The results are no less than marvelous. The dosage is given in each case.

In conclusion, it would seem that a standard technique could be adopted for deep therapy. The author favors 100–105 kilo-volts, together with 6 millimeters of aluminum and sole leather filter working at an 8 inch anode skin distance. This technique combined with massive dosage in experienced hands will result in the maximum good from deep *x*-ray therapy in malignant growths.

Mr. D. C. C., 56, married, farmer. January 1, 1918, his throat began to get sore with difficulty in swallowing. In May a local physician sent him to Denver for diagnosis when Dr. E. C. Hill examined a section and found it to be small round cell sarcoma. Later Dr. Bevan recommended ligation of the carotid artery and radium therapy.

Examination—July 19, 1918. Patient swallows liquids with difficulty, can only speak in a whisper. The entire pharynx is filled with a growth, smooth in character and apparently arising from the right tonsil. The right submaxillary and cervical glands are enlarged to the size of the patient's fist.

Treatment—105 kilo-volts, 6 millimeters of aluminum and sole leather, 8 inch anode skin distance, 200 milliampere minutes over each side of neck and down over the mediastinum. He had a second series of treatments, one month later, using the same setting, giving 175 milliampere minutes. Two months later he had a third series with the same setting, using 150 milliampere minutes.

Results: The third morning after having had only two days' treatment, he walked into the office very happy because he had been able to eat a breakfast of griddle cakes, swallowing them without difficulty. A recent examination showed no evidence of the growth or of metastasis. He is in good health nineteen months after treatment.

Mrs. F. H., 44 years old, weight 90 pounds. Four years ago she noticed a lump in the right breast. July, 1915, she consulted a doctor who found trouble in both breasts. In 1915 she visited the Mayo Clinic when they found cancer of the uterus, liver and both breasts. She was referred for roentgen therapy, coming December 13, 1915.

Technique—105 kilo-volts, 6 millimeters of aluminum and sole leather, 8 inch anode skin distance. A total of 1050 milliampere minutes divided into fourteen series.

Results: She has had eighty-seven treatments, comprising fourteen series, covering the entire torso from the chin to the pubes—front, back and both sides. When she came she was bedfast and unable to eat or sleep because of the pain. Her pain disappeared, the uterine hemorrhage ceased, she gained weight, was able to sleep and eat anything she liked. She has been doing her own housework for more than four years. Both breasts are soft and the liver is barely palpable, while the uterus is freely movable and normal size.

FIG. I. Front view photograph of patient suffering from extensive sarcoma of right maxillary sinus which had ruptured through the outer wall and was crowding the eye.

FIG. II. Oblique view of patient shown in Fig. I, showing the size of the growth on the outer surface of the cheek. The growth filled the entire right antrum, the right nares and protruded into the naso-pharynx.

FIG. III. Same patient after treatment was completed. This patient was treated with the following technique: 105 kilo-volts, 6 millimeters of aluminum and sole leather filter, 8 inch anode skin distance, 200 milliampere minutes over each area at the first seance. 125 milliampere minutes the second seance and 75 milliampere minutes at each of two more seances.

ABSORPTION AND SCATTERING OF X-RAYS

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The absorption of x-rays in their passage through matter is closely analogous, both qualitatively and quantitatively, to that of light.

Qualitatively, the absorption in both cases consists of two parts, which are usually called "true absorption" and "scattering". True absorption is a transformation of the x-rays or light into heat and chemical energy. Scattering is simply a change of direction of the x-rays or light. Examples of scattering in the case of light are reflection, refraction, and diffuse scattering by rough or milky substances. In the case of x-rays the scattering is generally diffuse, but crystals will reflect x-rays very perfectly if placed at the proper angle. Refraction of x-rays has not yet been observed.

Quantitatively, the absorption of x-rays is much simpler than that of light. The absorption of a given substance for x-rays is the same whether it be solid, liquid, or chemically combined with another substance, whereas the absorption of light depends almost entirely upon the physical and chemical state. The order of magnitude of absorption is about the same in the two cases. Organic solids and most metals are more transparent to x-rays than to light. Organic liquids, on the other hand, and most crystals and glasses, are more transparent to light than to x-rays.

The purpose of this article is to discuss (1) the mechanism of absorption of x-rays; (2) the magnitude of absorption, and the laws that govern it; (3) some simple applications.

THE MECHANISM OF ABSORPTION AND SCATTERING OF x-RAYS

True absorption of x-rays is due to the ionization by the rays, of the atoms of the absorbing substance. This ionization is of a special kind. It consists, like all ionization, in the loss by the atom of one of its electrons. But this electron is, in the first place, one of the most difficultly removable electrons in the atom, so that a large amount of energy is required to remove it; and, secondly, it is ejected with high velocity, comparable to that of some of the beta particles of radium. Hence, in addition to absorbing the energy of the primary x-rays, this ionization has two important results: (1) The ejected electron, or *corpuscular ray,* as it is sometimes called, plows through the atoms in its neighborhood, just like a beta particle of radium, ionizing every atom in its path. A single corpuscular ray produces several thousand ions before it is finally brought to rest. The number of atoms ionized directly by the rays is therefore a very small fraction of the total number ionized. Since chemical and physiological effects depend upon ionization, it is evident that the high speed *corpuscular rays* are the workmen who produce these effects. It is also to be anticipated that the physiological and chemical effects of x-rays and radium will be identical, except as regards distribution. (2) The second result of the initial ionization of an atom takes place when it "recombines", *i. e.* acquires an electron to fill the place of the one that was lost. This gives rise to *secondary* x-rays, sometimes called *Characteristic* x-rays, because their wave length is characteristic of the element that produces them, or *fluorescent* x-rays because, like fluorescence, their wave length is always longer than that of the rays that produced them. These secondary rays are absorbed in the same way as the primary rays, giving rise to more corpuscular rays and to *tertiary* x-rays of still longer wave length, and so on until all the energy is used up.

Scattering of x-rays is a much simpler phenomenon than

absorption. It is simply a re-radiation, in new directions, of the original rays. X-rays are electric waves. When they pass through atoms they set all the electrons in the atoms into oscillation, riding on the waves, so to speak. These oscillating electrons radiate a small fraction of the energy of their oscillation as scattered radiation. It is called *scattered* to indicate that it is identical in quality with the primary rays, but is radiated in all directions. It sometimes happens that a large fraction of the scattered rays reunite in some particular direction, causing regular reflection. This is the case with crystals, whose atoms are arranged in equidistant parallel planes. The reflection takes place only when the crystal is placed at exactly the right angle, and hence can be used to separate the *x*-ray wave lengths into a spectrum.

THE MAGNITUDE OF ABSORPTION AND SCATTERING

The absorbing power of a substance depends in a very simple way upon the kind of substance and the wave length of the rays. It is usually expressed in terms of an *absorption coefficient*,* which is the *rate of decrease of intensity of the rays per unit thickness of material traversed*, or the *mass absorption coefficient*, which is the absorption coefficient divided by the density.

In terms of the latter quantity the absorbing power of all substances for all wave lengths shorter than that of the characteristic K radiation of the substance, can be expressed, within the limits of accuracy of our present knowledge, by the following very simple law:

*The coefficient of absorption corresponds to the rate of compound interest, reckoned as a loss instead of gain. It may be called the rate of compound loss. If the loss were subtracted only after each centimeter traversed, the intensity I after traversing X cm. would be given by the compound interest law — $I = Io\ (1-\mu)^x$ where Io is the original intensity and μ the absorption coefficient or rate of loss per cm. When, as in actual absorption, the loss is subtracted after each infinitesimal thickness traversed, this expression becomes —

$$I = Ioe^{-\mu x} \quad (e = \text{base of natural logarithms})$$

This is the usual definition of absorption coefficient.

The mass absorption coefficient is proportional to the cube of the atomic number of the absorbing substance and the cube of the wave-length of the x-rays; or, in symbols:

$$\frac{\mu_0}{\rho} = .00556\ N^3\ \lambda^3\ ;\ \lambda < \lambda_k \qquad (1)$$

μ_0 is the true absorption coefficient in C. G. S. units.

P is the density of the absorber in grams per cc.

N is the atomic number of the absorbing element.

λ is the wave lengths of the x-rays in Angströms.

λ_k is the wave length of the limit of the K series of the element.

The scattering of x-rays obeys a still simpler law. It is practically the same for all substances and all wave lengths. Over the range of practical wave lengths it may be expressed with sufficient accuracy by the law:

The mass scattering coefficient is the same for all substances and all wave lengths. In c. g. s. units this constant value is 0.14.

$$\frac{S}{P} = .14 \qquad (2)$$

The total loss of energy in the x-ray beam per centimeter of absorbing material traversed is the sum of the true absorption and scattering. If we call this the *apparent absorption*, and denote its coefficient by μ, it will be expressed by the formula—

$$\frac{\mu}{P} = .00556\ N^3\lambda^3 + 0.14;\ \lambda < \lambda_k \quad (3)$$

It is this *apparent* absorption which is usually observed, and is of greatest practical interest.

These relations are illustrated in the following figures and tables:

Figure *1* is a photograph of the x-ray spectrum of tungsten at 100,000 volts, showing the K series lines, α_1, β_1, at the left and the L series lines, a, b, c, etc., at the right, superimposed upon the general white radiation. The wave lengths are proportional to the distance measured from the

central line C. The limit of the K series of tungsten is just to the left of β_1, at $\lambda = .1785$ Angströms, and the limit of the K series of silver is shown by the absorption band Ag1, at $\lambda = .485$ Angströms.

Figure *2* shows a series of photographs of the K series lines of several elements. The limits of these series are just to the left of the line of shortest wave length in each case.

Table *1* gives the wave lengths in Angströms of the K series limits of all the elements for which this limit has been measured, and also the atomic numbers of the elements.

Figure *3* is a graphical representation of equation 3, showing the variation of total or apparent absorption with wave length for six different substances.

Figure *4* is the same series of curves as Fig. 3, plotted to a smaller scale, so as to show the values of $\frac{\mu}{\rho}$ for wave lengths greater than the limit of the K series, where equation 3 no longer applies. The equation similar to equation 3 applies to this range, but sufficient data is not available to determine the constants. The sudden drop in absorption at the wave length of the K series limit is responsible for the sharp bands in Figures 1 and 8.

Figure *5* is a test of Equation 3. Figure *5(a)* is a photograph taken with rays of wave length $\lambda = .211$ Angströms through equivalent thicknesses of six different materials, *i. e.,* such thicknesses as should give equal absorption according to equation 3. These thicknesses are:

Water	12.0 cm.	Molybdenum	.050 cm.
Aluminum ..	2.9 cm.	Silver	.034 cm.
Copper	0.158 cm.	Tin	.041 cm.

These thicknesses are just sufficient, according to equation 3, to absorb nine-tenths of the energy of rays of wave length .211 A. The equality of blackness of the six areas, in spite of the enormous difference in absorption coefficient, is proof that the equation is accurate enough for practical

purposes. Figure *5(b)* is a photograph taken with wave length $\lambda = .712$ A, through thicknesses just one-seventh as great as those in Figure 5(a). If equation 3 held for this wave length these areas should also be of equal blackness. This is true of water, aluminum, and copper. For molybdenum, silver, and tin, however, the wave length .712 is greater than the limit of the K series, as is evident from Figure 4 or Table 1, so that Eq. 3 does not apply. The absorption coefficients are much smaller than would be given by equation 3, hence the greater blackening.

APPLICATIONS

Three simple applications of the principles discussed above may be of interest:

1. *Production of Monochromatic X-rays.* The sudden jump of about seven fold in the absorption coefficient at the wave length of the K series limit makes it possible to cut off very completely the wave lengths just shorter than this without greatly affecting those just longer. This gives a sharp band as in Figure 8. On the long wave length side the limitation is not so sharp, but the fact that the absorption increases as the cube of the wave length makes the intensity fall off to an inappreciative value in a very short range of wave lengths, leaving nearly monochromatic rays. If, in addition, the range of wave lengths that is left includes one of the intense lines in the spectrum, such as a_1, in Figure 1, the monochromatic rays thus produced may be of sufficient intensity for many practical purposes. Figure 6 shows the spectrum of tungsten filtered in this way to give monochromatic rays of wave length $\lambda = .211$ A. The upper part of the photograph is the unfiltered spectrum; the lower part has passed through a filter of Ytterbium. Figure 7 shows the spectrum of molybdenum before and after filtering with zirconium. The filter has cut off very completely the rays of wave length just shorter than .687 A, and has reduced the line $\lambda = .638$ A from an initial intensity of 39 to less than 0.3, while reducing the line

$\lambda = .712$ from 62 to 10. This is the monochromatic source used in taking the photographs shown in Figures 8 and 9, and this and the monochromatic line .211 shown in Figure 6 were used in taking the photographs shown in Figure 5.

2. *X-ray Chemical Analysis—Absorption Method*—The sharp absorption bands produced by the sudden jump in the absorption coefficient at the wave length of the K series limit can be utilized for identifying an unknown substance. The substance to be tested is placed, as an absorbing filter, between the x-ray tube and the crystal which separates the wave lengths into a spectrum. The spectrum will then show a pronounced band, and a comparison of the wave lengths of this band with the values in Table 1 tells what the unknown substance is. Figure 8 shows a spectrum photographed in this way. The upper portion is the unfiltered spectrum the middle portion that of the rays which had passed through a molybdenum filter; and the lower portion that of rays filtered by an unknown substance, which was suspected of being a compound of molybdenum. It is evident that the unknown substance contained no trace of molybdenum. Further tests, by the method described below, showed it to be potassium sulphate.

3. *X-ray Chemical Analysis—Powder Pattern Method*—This method utilizes the scattering of x-rays. When monochromatic x-rays fall on a crystalline powder they are scattered only in certain definite directions, determined by the crystalline structure of the powder. A photographic plate placed in the path of the rays will show, in addition to the direct beam, a series of circles, whose diameters and relative blackness are characteristic for each particular powder, and can be used to identify it. Figure 9 is a photograph taken in this manner through aluminum powder. Figure 10 shows sections of a series of photographs of different powders, showing how extremely different the patterns are. All crystalline powders give patterns of this kind, and no two of the patterns obtained thus far are alike. Hence these patterns offer a simple and infallible method of identification of any crystalline material.

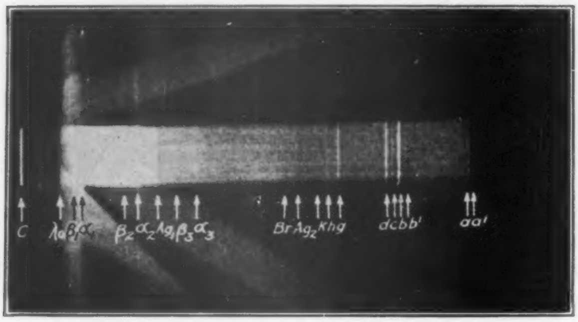


FIGURE 1
X-Ray Spectrum of Tungsten at 100,000 Volts

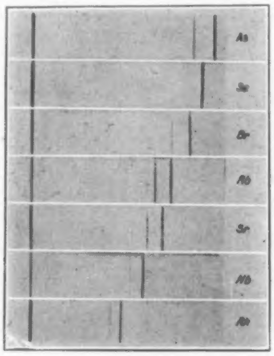


FIGURE 2
X-Ray Spectra Showing K Series Lines

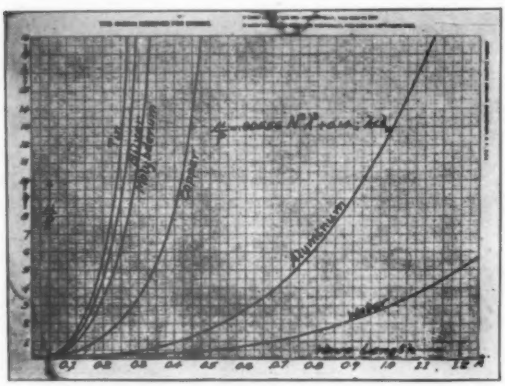


FIGURE 3
Variation of Absorption with Wave-Length

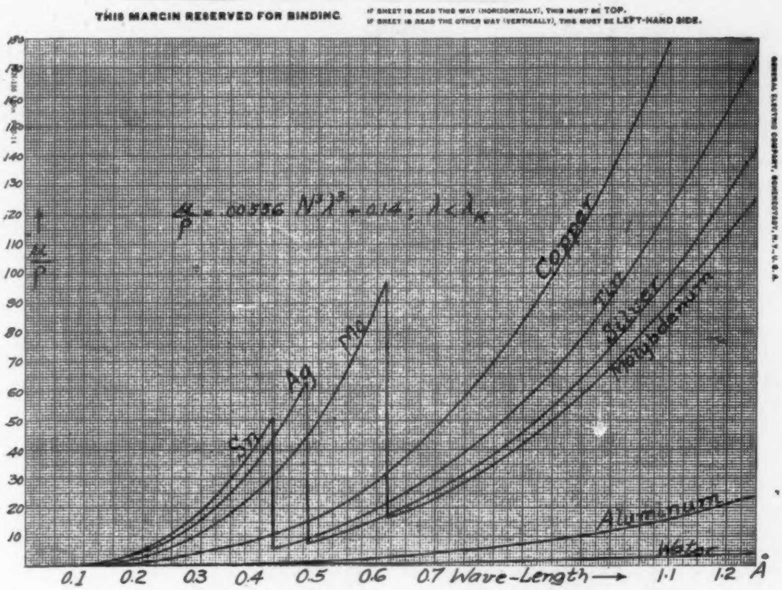


FIGURE 4

Variation of Absorption with Wave-Length

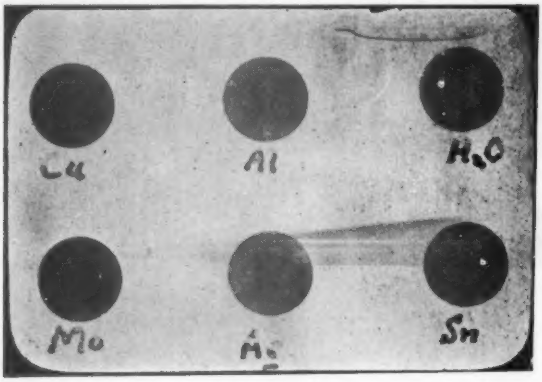
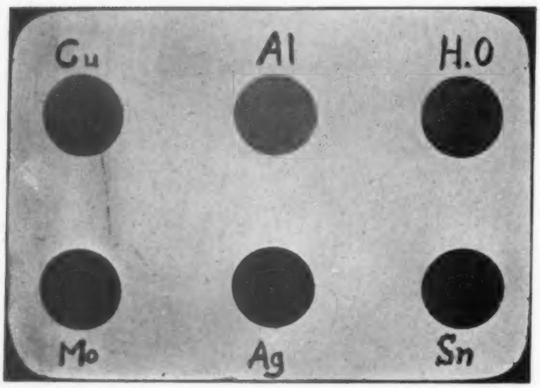


FIGURE 5

Test of Absorption Law Absorption of Equivalent Thicknesses

a

$\lambda = .211$ Angströms



b

$\lambda = .712$ Angströms

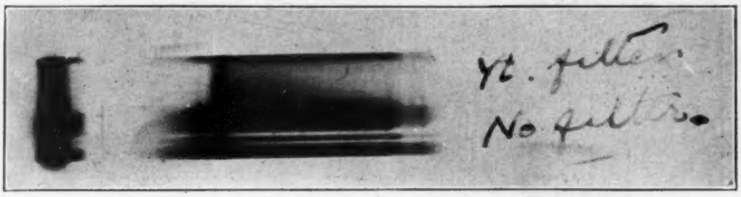


FIGURE 6

Monochromatic X-Rays. $\lambda = .211$ Angströms

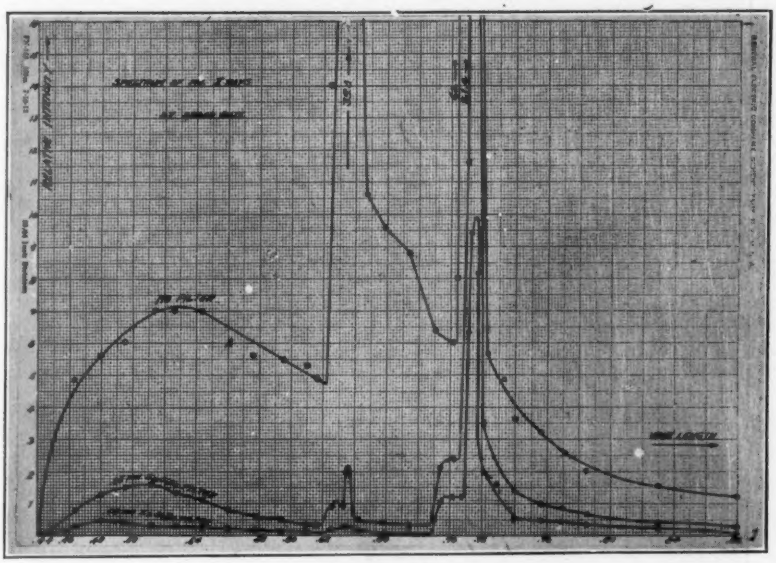


FIGURE 7

Monochromatic X-Rays. $\lambda = .712$ Angströms

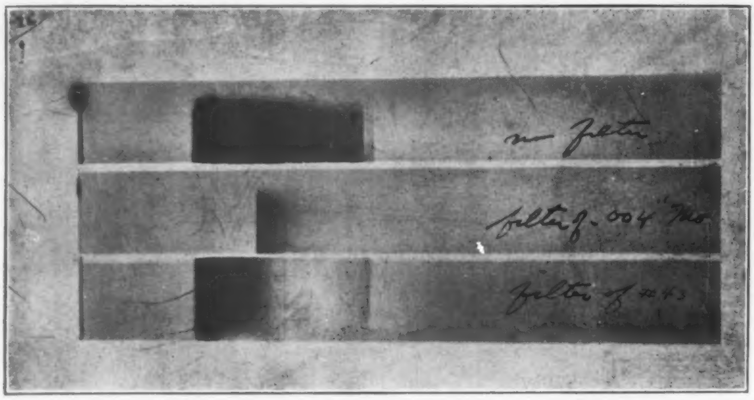


FIGURE 8
Chemical Analysis by *X*-Ray Absorption

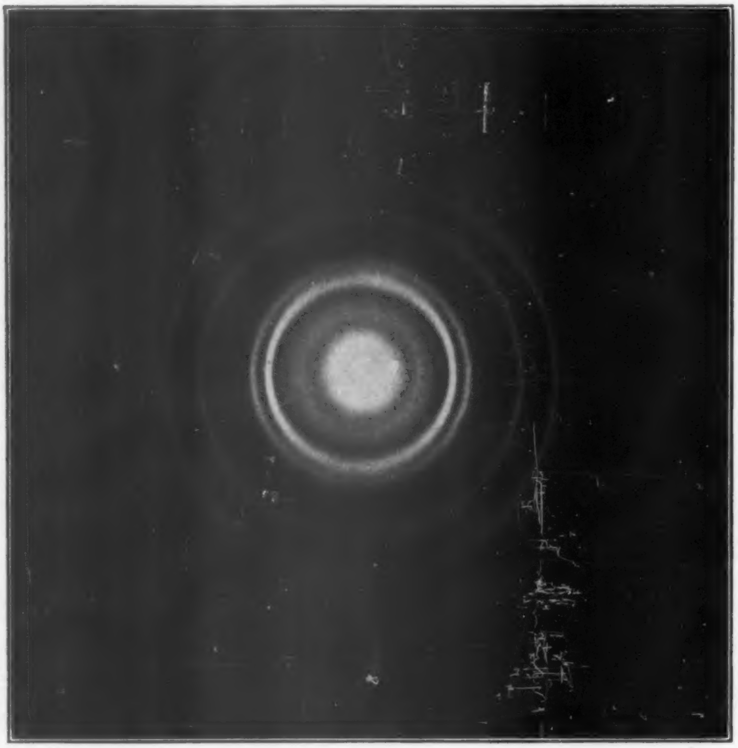


FIGURE 9
X-Ray Powder Pattern of Aluminum

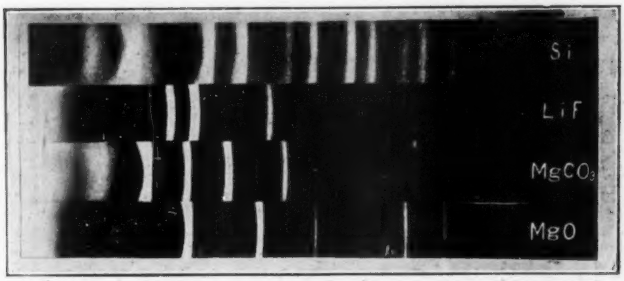


FIGURE 10

Typical X-Ray Powder Patterns

LOCALIZATION OF FOREIGN BODIES IN THE EYE

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In presenting this subject I will not attempt to bring out anything new or startling, but to go over the different methods that we may become more familiar with the technique of each and decide for ourselves which we believe to be the most accurate and least liable to permit of error.

Naturally, the first efforts to locate foreign bodies in the eye by the *x*-ray were rather crude, compared to the elaborate apparatus of today. It consisted simply of a lead ring made of heavy fuse wire and divided into quadrants by cross-pieces of smaller fuse wire. This ring was then fitted over the injured eye as high under the orbital ridge as it could be pushed, the crossed wires touching the closed lids. In size the ring was slightly larger than the eye-ball. The ring was held in place with a pledget of cotton and a strip of adhesive plaster. Two exposures were then made, one directly anteroposterior with the nose and forehead touching the plate, and one lateral. This showed in what quadrant of the eye-ball the foreign body is located and its apparent depth.

We will next take up the method of use of the Sweet Bowen localizer. This consists of two parts: the table and head rest, and the localizer proper. The table is so made that it carries a sliding plate holder that slips into a tunnel just under the top board. The top is covered partly with metal so that only half of the plate is exposed at one time; the unexposed half being covered during the first exposure and the exposed half covered during the second exposure. The table is also provided with clamps for holding the head perfectly still. This table is just four inches in height, so that it really takes the place of a pillow, and holds the head

level with the rest of the body when the patient is lying on his side. The plate carrier is so marked as to show just where to place the plate for each exposure.

It is assumed that before the use of any localization method you have first made and developed a single lateral plate to determine positively the presence of a foreign body.

The localizer is a small instrument on a heavy base or standard, with an upright arm for adjusting the localizer points up or down. The two points, one of which is tipped with a ball and the other a cone, are a known distance apart (15 mm.). Along the top of the localizer are sights similar to those on a rifle for centering the ball to the center of the pupil of the eye. The other end of the localizer is a sliding arm in a sleeve held with a spring and a trigger. This arm is now pushed forward until the trigger engages and the whole apparatus sighted to the center of the pupil, being careful to preserve as nearly as possible the axis of the eye. The eye is closed and the ball of the localizer pushed against the lid over the center of the pupil and the trigger pressed. This lets the whole arm of the localizer jump back so that the ball is just 10 mm. from the cornea of the eye. This 10 mm. must be taken into consideration when drawing the chart. The patient is now instructed to look steadily at a fixed object, preferably a lighted candle, some distance away and in a line with the localizer. This brings the axis of the eye in direct line with the localizer. The plate is now placed in the plate carrier and introduced into the tunnel with the first half ready for exposure. The tube is centered directly above the eyes of the patient and perpendicular so that in the first exposure the localizer ball and cone will coincide and will make only one shadow on the plate. After this exposure is made the tube is moved toward the feet of the patient some six to ten inches and tilted so as to direct the rays through the eyes. The unexposed half of the plate is put in position and the second exposure is made. The plate is now ready for development.

My procedure here is to let the patient get up and then

proceed to make another localization, going through identically the same process as in the first one. Both plates are then developed and if the measurements on the two plates differ more than one mm., both are discarded and two new ones made. This seems to me to be the only accurate way to check up this work.

As soon as the plates are dry we are ready to proceed with the drawing of the chart. These charts are obtained from the makers of the instrument and are printed accurately. Each little square is just one mm. in size and larger squares 10 mm. in size. The use of a mm. rule is necessary and a small pair of dividers are a help, but not indispensable.

On the half of the plate exposed first a line is now drawn through the horizontal axis of the ball and cone which are superimposed and at right angles to this a line is drawn through the foreign body. As an aid to measurement a line is drawn through the foreign body parallel with the line through the ball and cone, and just touching the ball and cone, remembering to deduct 10 mm. from this measurement, as both ball and cone were jumped back just this distance when the trigger was pressed.

Now going to the second exposure in which the ball and cone are separated we draw a line through the longitudinal axis of the ball and another through the same axis of the cone; also a line through the foreign body at right angles to these two lines. A line is also drawn at right angles to the axis of the ball and cone and just touching them. Still remember to subtract 10 mm. from the distance between line through the foreign body and the line touching the ball and cone.

We are now ready to begin making our actual measurements. The dividers are very convenient for this, but not actually necessary, as the plate can be held to the light and the mm. rule can be applied directly to the plate. We first measure the distance of the foreign body above or below a line drawn through the axis of the localizer and draw a line

on the chart across the front view of the eye-ball just this distance above or below center. This measurement is taken from the first exposure. We next take the second exposure and measure the distance above or below the ball and place a dot on the chart in the mid-line corresponding to this measurement. We do the same with the cone and put a dot in the dotted line just 15 mm. from the ball line as placed on the chart for this purpose. These two dots are now connected by a line drawn through them. Where the first and second lines cross is the location of the foreign body in the front view. We now draw a line upward through this crossing point, following the mm. lines on the chart and through the horizontal view, and then measure on the first exposure the depth of the foreign body, not forgetting to deduct the 10 mm. and draw a line at right angles to the line extending through the horizontal view. For the side view measure the distance above or below the center of the cornea, as in the first view, and draw in the side view and the depth of the horizontal view and draw at right angles to the first line in the side view and where the lines cross is the location of the foreign body in the side view. All that is left to do now is to count the little squares and set down so many mm. above or below the center of the cornea and so many to either the nasal or temporal side and so many deep. If your technique is perfect the result will be perfect. The greatest difficulty in all methods of localization of foreign bodies in the eye is to keep the patient looking steadily at a given object so as not to rotate the eye-ball. As these cases most often occur among uneducated foreigners, it is often hard to make them understand this and do as you tell them.

The latest method devised for this work is the improved Sweet's eye localizer. This is at first sight a complicated piece of apparatus, but when understood can be handled very readily. The first requirement is to have the tube accurately centered in the bowl. This is very important, for the reason that if it is not accurately centered the indi-

cator shadows on the plate will not coincide with the indicator spots on the key plate and thus give you a false reading.

The instrument consists of a movable head rest and clamps, and arm that lifts up and allows the placing of the patient in position and also carries the sighting attachment and the plate. Also a tube holder and carrier, which allows the tube to be slid along a track. There are small wheels for adjusting the sighting attachment and the head rest. Wheel A raises and lowers the whole tube carriage and arm; B tightens the head clamps; C adjusts head rest laterally, and D adjusts it longitudinally. Please pay especial attention to the little ring marked "E", as this is the indicator that appears on the plate and is also a part of the sighting apparatus. This will be referred to frequently as the indicator. The rest of the sighting apparatus consists of a mirror with a hole in it that is directly above the indicator. Also what is called a telescope, but in reality is an inverted periscope. This contains in its lower end a mirror set at an angle of 45 degrees, and a cross wire. There is also a flashlight that throws a small amount of light through a hole directly on the eye. The shutters for protecting the unused part of the plate are also carried on the arm.

The whole instrument is placed on the end of the *x*-ray table and the arm of the localizer raised and the patient on his back and his head in the head clamps with the injured eye farthest away from the tube. Sighting down through the hole in the mirror and the hole in the indicator the wheels are manipulated until the indicator exactly centers over the pupil of the eye. Now sighting through the inverted periscope the carriage is raised or lowered until the cross wire appears to be exactly over and touching the cornea. Your indicator is now exactly 10 mm. from the cornea. The shutters are now separated so that only the center of the plate is exposed. A five by seven plate is placed in the clips and the tube slipped in the center notch

and the first exposure made. Before making a second exposure it is always best to look through the periscope to make sure the patient has not moved. Patient is instructed to look constantly at the hole in the mirror. The principle of the sighting apparatus is best explained by the following drawing. The tube is now shifted on its track as far as it will go toward the feet of the patient and the shutter farthest from the feet of the patient is shifted toward the feet to cover the exposed center of the plate and the second exposure made. I always go through the entire procedure a second time and both plates must check up within one mm. or both are discarded. It is always best to ground the instrument to prevent static sparks to the patient.

After the plate is developed, both exposures will look like this. Notice the shadows of the indicator in the upper part of the plate. These indicators should exactly coincide with the rings and dots on the key plate and will do so if the tube has been exactly centered in the bowl. The way the key plate is constructed you are supposed to have the *x*-ray plate dry before taking the measurements. The time of washing and drying can be saved by reversing the key plate and putting the glass side of the *x*-ray plate to the reversed side of the key plate. The readings are exactly the same except that the letters are backward and left should read right, and *vice versa.* It is now only necessary to set down three readings: one each for above or below center, one for nasal or temporal side, and one for depth. On the chart that is already printed, the exact angle at which the second exposure is made is preserved. The little squares in the key plate are laid off in two mm. size and the large square are in 10 mm. In the key plate A and B determine whether above or below the center of the cornea, and C and D whether to the temporal or nasal, and E the depth. It is not necessary to make any measurement with this method, as that is taken care of by the key plate.

For illustration, we will say that our figures taken by putting the *x*-ray plate against the key plate are B 2, D 2,

and E 14, drawing a line along B 2, through the front view of the eye and also a line through D 2, till they cross, will give the location of the foreign body in the front view. A line is drawn through this crossing point and through the horizontal view. A line is now drawn along E 14, until it crosses the line in the horizontal view. From the first view and the horizontal view it is an easy matter to draw the side view. The reading would now be 2 mm. below center, 6mm to nasal side, and 10 mm. deep. By not having to wait for the washing and drying of the plate this is the most rapid method with which I am acquainted. Also it is the most accurate.

Doctor Titterington: As far as the indicator points becoming bent is concerned, I always measure them before I use them to see they are just fifteen millimeters apart. I have never checked up both methods on the same case. I have often thought I would, but have simply neglected to do so. One great source of error is the rotation of the eye. That is the hardest part of the whole thing—to get the patient to look steadily at one given object, because if a patient is looking at one object in one exposure and at another object in the second exposure, you are likely to get them clear in front of the eye or clear out to one side. As I tried to bring out in the paper, that the most important thing is to insist, absolutely, that they look at one given point, and do it all the time. Do not have them look just when you are giving the exposure. Tell them to look all the time.

Doctor Titterington: Nothing more.

Doctor Briggs: The Doctor has brought out a number of times in the paper the importance of that ten millimeter allowance for the shift of the indicator shaft. I had a case some time ago where, using the first method he has described, we found the localization approximately a millimeter anteriorally, or in front of the anterior margin of the cornea. On a shift examination it was possibly a half millimeter in front. On making an examination of the eye I

found a small piece of shell imbedded in the conjunctiva, with a small film of conjunctiva lying over the foreign body, so the foreign body practically was outside the eye, although anatomically it was not.

About 1917 I had my attention called to a case where one of the laboratories had attempted to localize a foreign body by means of the first method of which he spoke. The chart was brought to the office and the foreign body localized about five millimeters in front of the eye, out in space. (Laughter.) I would like to ask the doctor if he has ever made any tests of the two methods on the same case; that is, using the old Sweet localizer and checking it up with the new Sweet localizer, to see which is the more accurate of the two, or if there is any difference?

Doctor Ernst: I would like to add a word of caution with reference to the first method described, regarding the ball and cone points on the Kelley-Koett Localizer. It would be well to measure these points previous to each examination. On two occasions I found no less than three-fourths of a millimeter difference; more than the 15 millimeter correct separation. That, of course, is sufficient to give us an incorrect localization.

212 Metropolitan Bldg.

FIG. 1. Posterior-anterior view with nose and forehead touching the plate.

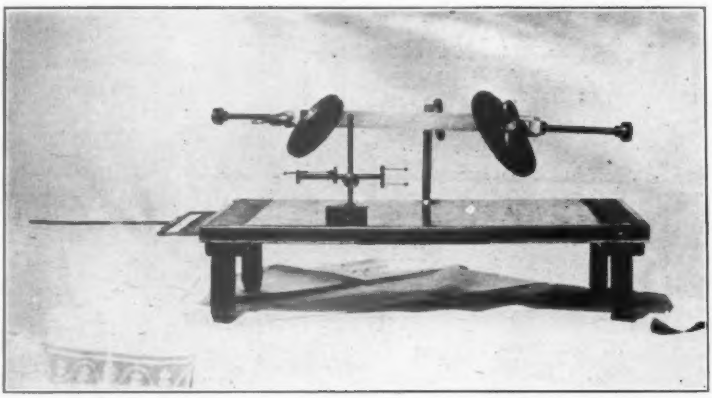

FIG. 2. This table carries a sliding plate holder that slips into a tunnel, just over the top board.

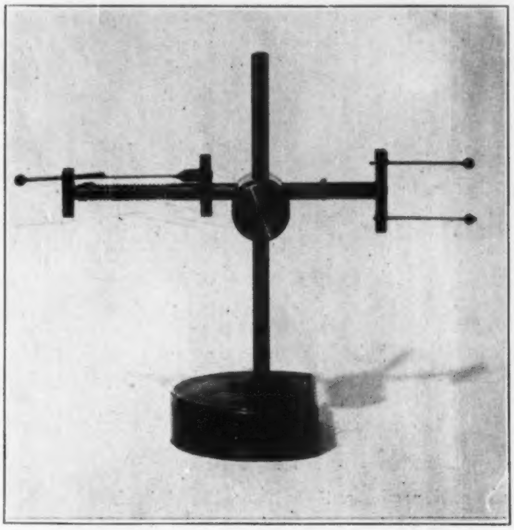

FIG. 3. The localizer showing an upright arm for adjusting the localizer points up or down.

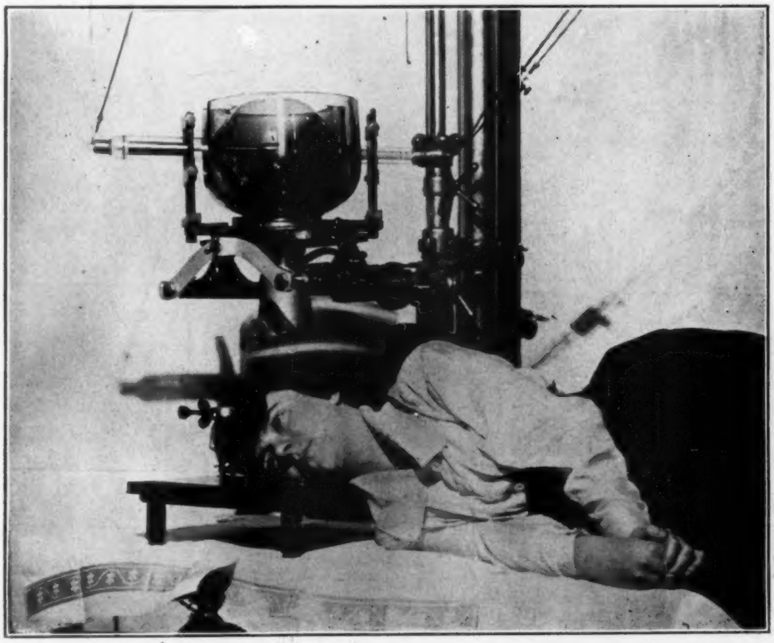

FIG. 4. Patient in position for the lateral exposure, which will show the localizer, ball and cone to coincide, and will make only one shadow on the plate.

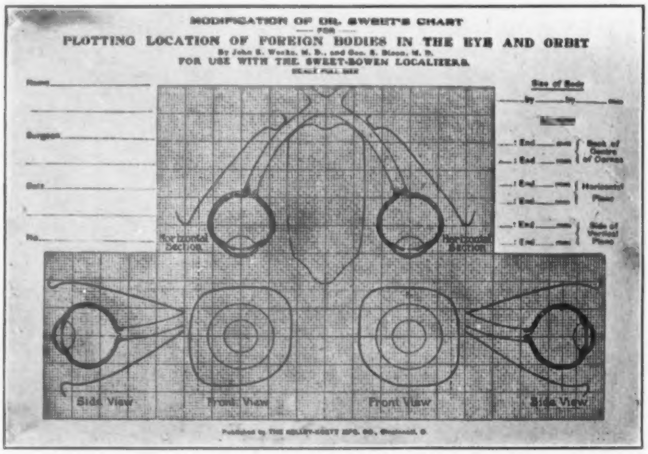

FIG. 5. Modification of Dr. Sweet's chart. The large squares are ten millimeters and the small ones one millimeter.

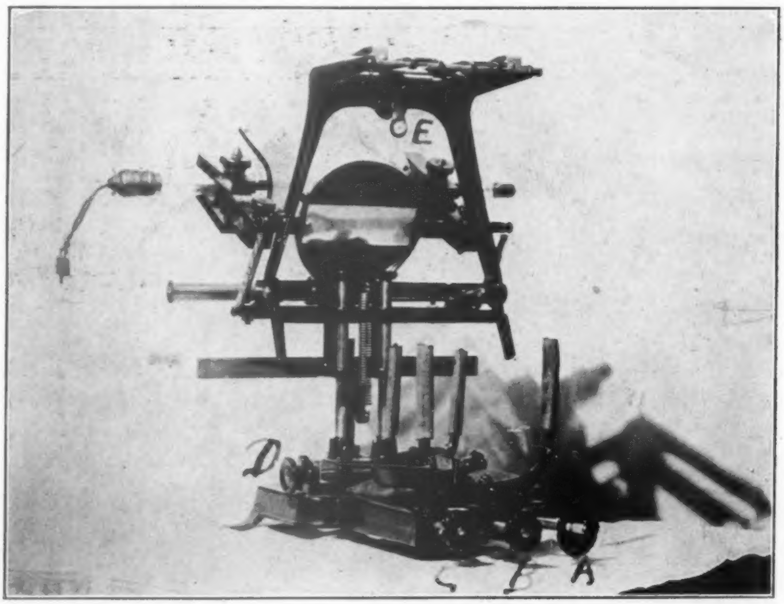

FIG. 6. Tube holder and headrest. Wheel A raises and lowers the tube. B, tightens the head clamp. V, adjusts the headrest laterally. D, adjusts the headrest longitudinally. E, sighting apparatus.

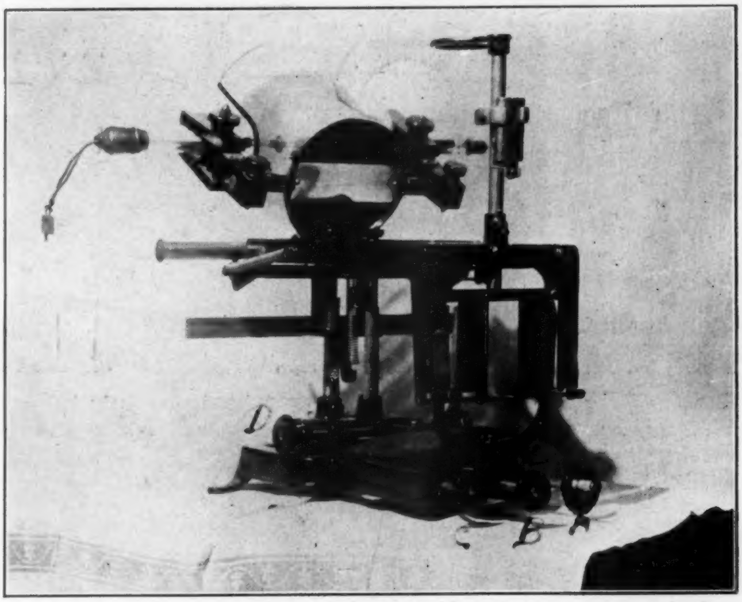

Fig. 7. The sighting apparatus, which is called a telescope, but in reality is an inverted periscope. This contains, in the lower end, a mirror, set at an angle of forty-five degrees, and a cross wire.

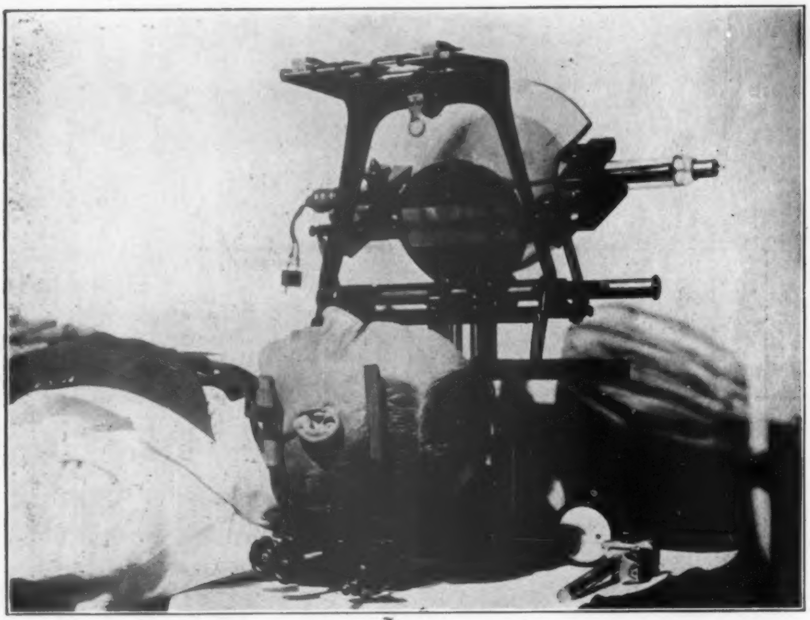

FIG. 8. Patient's head in position, with the injured eye farthest from the tube. Sighting down through the hole in the mirror and the hole in the indicator the instrument is manipulated until the indicator exactly centers over the pupil of the eye.

FIG. 9. Shutter closed to center over the eye.

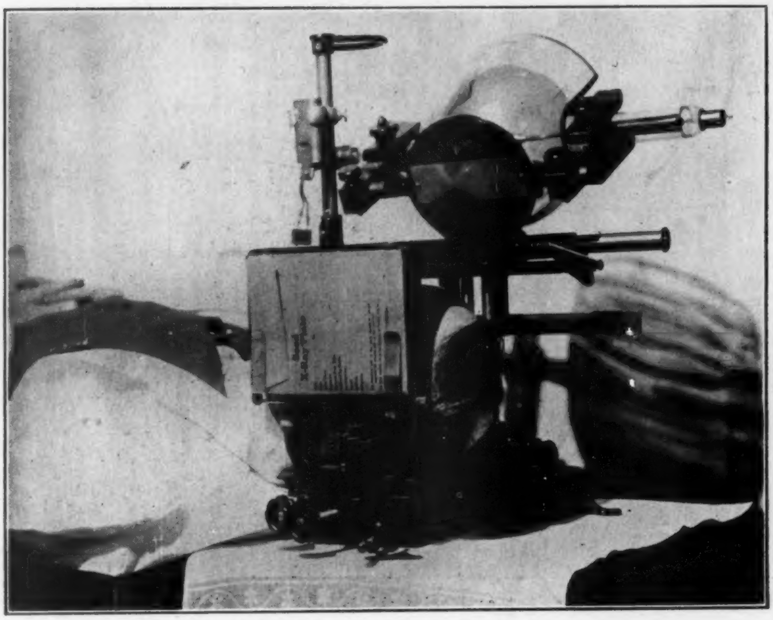

FIG. 10. Plate in position, ready for exposures.

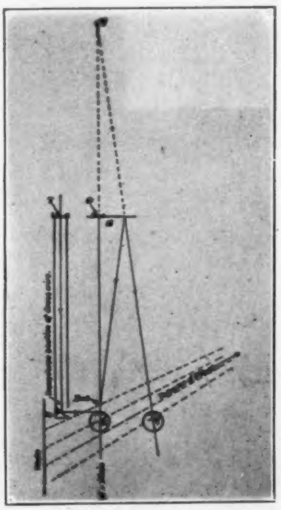

FIG. 11. The principles of the sighting apparatus.

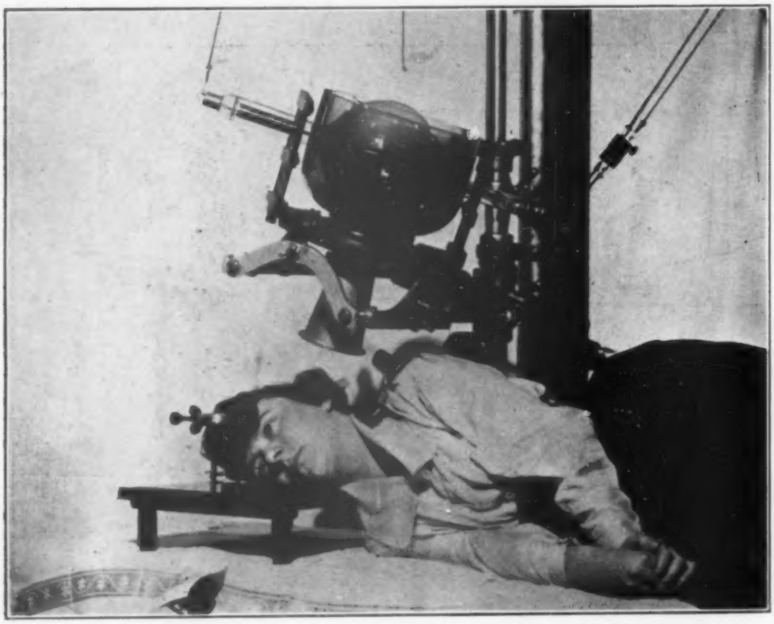

FIG. 12. Patient and tube shifted for second exposure.

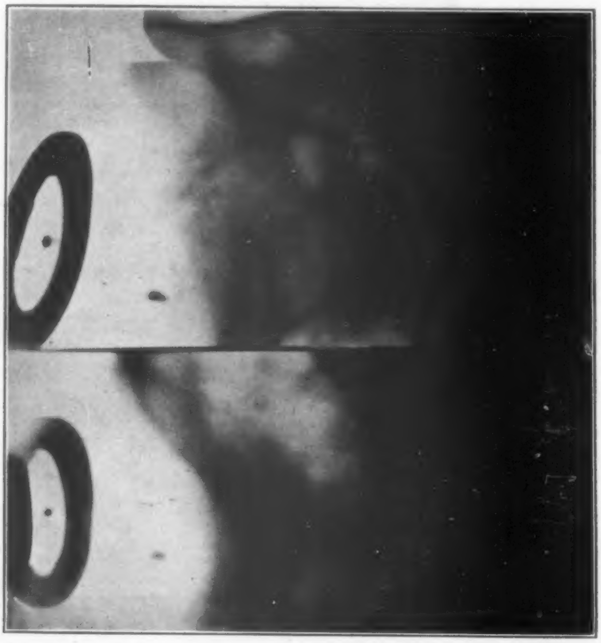

FIG. 13. Plate showing the relation of the foreign body to cone and ball in both exposures.

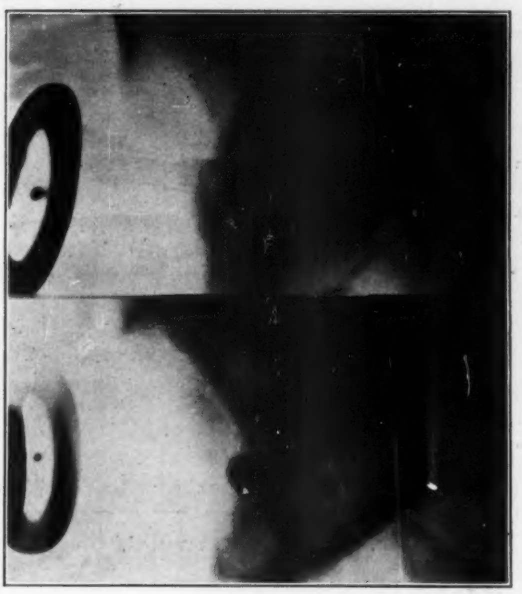

FIG. 14. These indicators should exactly coincide with the rings and **dots** on the key plate, and will do so if the tube has been exactly centered **in the** bowl.

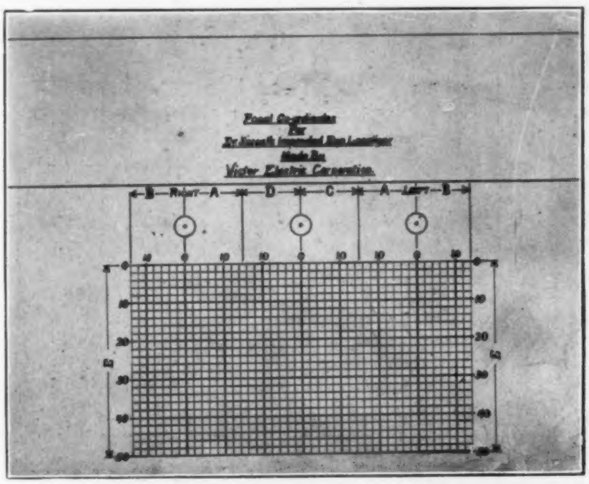

FIG. 15. Focal coördinates for Dr. Sweet's improved eye **localizer.**

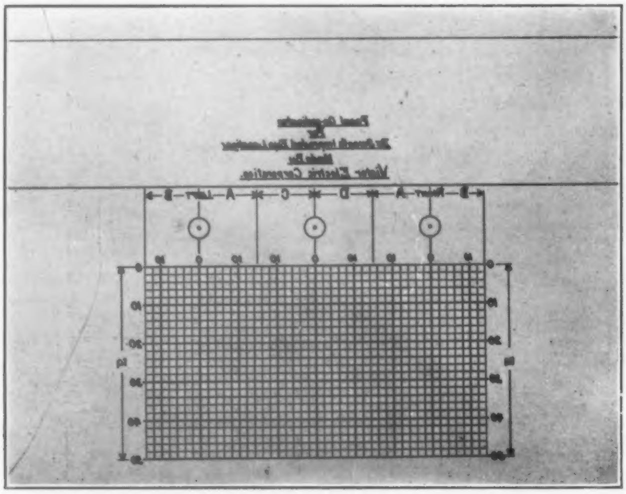

FIG. 16. Key plate reversed.

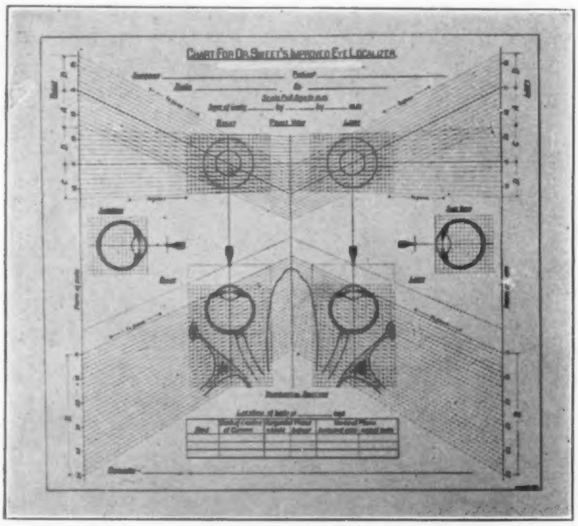

FIG. 17. Chart for Dr. Sweet's improved eye localizer.

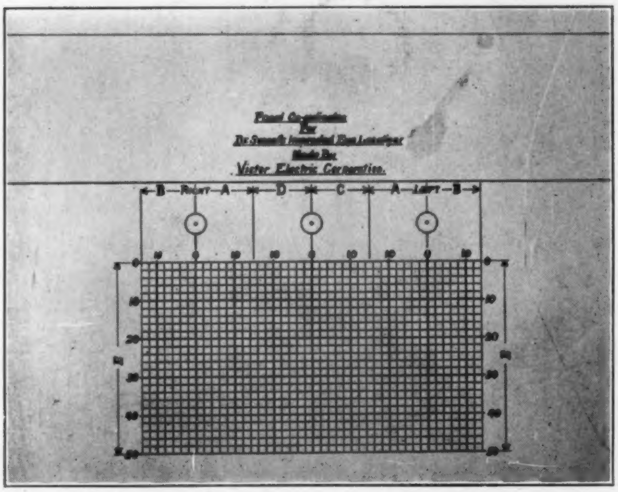

FIG. 18. In the key plate A and B determine whether above or below the center of the cornea, and C and D whether to the temporal or nasal and E the depth. It is not necessary to make any measurement with this method as that is all taken care of by the key plate.

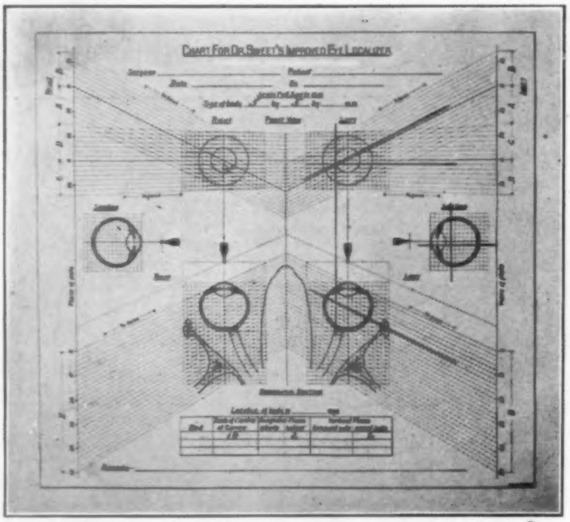

FIG. 19. For illustration we will say that our figures taken by putting the x-ray plate against the key plate are B 2, D 2, and E 14, drawing a line along B 2, through the front view of the eye and also a line through D 2, till they cross, will give the location of the foreign body in the front view. A line is drawn through this crossing point and through the horizontal view. A line is now drawn along E 14, until it crosses the line in the horizontal view. From the first view and the horizontal view it is an easy matter to draw the side view. Our reading would now be two millimeters below center, six millimeters to nasal side and ten millimeters deep.

CONGENITAL PYLORIC STENOSIS

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In the discussion of congenital pyloric stenosis I shall endeavor to present a more accurate and concise method of diagnosis. This method has been used in over 100 cases with absolute exactness, the operative findings confirming a positive diagnosis in every instance. Not only is it my belief that the roentgen findings are almost infallible when a proper technic is used, but in a case of partial stenosis the roentgen ray should be the means of deciding upon an early and immediate operation, as the condition is usually a progressive one and the pathology is not so marked, giving the infant the best possible chance for recovery, inasmuch as its vitality is at its best.

The pathology found in this class of patients consists of a muscular hypertrophy of the pyloric sphincter. The etiological factor in this condition is a mooted question and I will not presume to discuss it here. The fact remains, however, that in a true stenosis there is always a tumor present in the sphincter. This tumor may be large or small and may involve the entire muscle or only a portion of it. A small hypertrophy of the entire muscle or a portion of it, may be sufficient to cause a complete pyloric stenosis, whereas even a large tumor might be so located in only a portion of the sphincter that it produces only a partial obstruction.

The difficulty of diagnosing the condition by clinical methods is not apparent at first glance. Quoting from a recent article: "The first symptom that attracts attention is vomiting, frequently beginning as a regurgitation which gradually becomes worse until it becomes distinctly projectile in character, the vomitus often being projected several feet.

It occurs after each feeding or after several retained feedings. There is nothing distinctive about the character of the vomitus. Of all the symptoms, the vomiting is the most alarming. A peristaltic wave appears after food is taken, and radiates from the cardia to the pylorus. A tumor may be felt to the right and above the level of the umbilicus, usually a small movable mass. There are scanty stools and urine and progressive loss of weight. It is now generally agreed that only in the mildest cases with partial retention and with no loss or little loss of weight should expectant treatment be tried. In all other cases, operation should be advised at once."

The question which here presents itself is, is this a pyloric stenosis or is it a case of pyloro-spasm? Is the etiological factor a pyloric hypertrophy, does it contain a neurotic element, or is it the result of a dietic error? It is here that the roentgen ray can with absolute accuracy make a differential diagnosis between these various conditions and so serve as an indication for the subsequent treatment.

Clinically these three conditions may show the same signs and symptoms. Visible abdominal peristalsis is usually accepted as an extremely valuable objective sign; coupled with projectile vomiting, loss of weight and inanition, the diagnosis of pyloric stenosis is usually made. Fluoroscopy has shown us the fallacy of these objective signs in this condition. Cases which have been diagnosed as congenital pyloric stenosis by the roentgen ray with confirmative operative findings, have shown us that this condition may exist with little visible abdominal peristalsis, although there may be a marked hyper-peristalsis of the stomach present. Again other cases which clinically appeared to be pyloric stenosis upon examination have shown conclusively that even with marked abdominal peristalsis, the pylorus opened and permitted readily the passage of the opaque meal. I am fully satisfied from our observations that visible gastric peristalsis may exist with or without stenosis, and that loss of weight may come on with or without stenosis. Clinically,

it is possible at times to palpate the tumor in the pylorus, yet this is a personal equation, in which out of a dozen men, one or two might be conscientiously able to say that the mass is palpable, the mass being however more readily palpable in the later stage. It is the early and accurate diagnosis in which we are chiefly concerned. The roentgen findings do not depend upon any of these signs but upon the functional condition of the pylorus itself.

Technic

It is essential that a careful technic be followed. Our routine consists in withdrawing the feeding prior to the first roentgen examination. This is essential for if a late feeding is permitted there are no means of ascertaining whether the fluid found in the stomach is a hyper-secretion, if such does occur, an abnormal retention, or the remains of the feeding which had been given within too short a time to be evacuated. In our early work the patient was given the opaque meal by means of a catheter. This was found to be extremely unsatisfactory, because even in normal patients the irritation of passing a catheter was sufficient to cause a regurgitation, which in many cases was difficult to distinguish from the stenotic type.

We now use the ordinary feeding bottle with a standard rubber nipple, the hole of which is usually too small to permit the passage of the opaque meal, so we simply cut it larger. The opaque meal consists, in accordance with the age of the child, of the proper amount of mother's milk, or if this is not obtainable, modified cow's milk will also be found satisfactory. Sufficient bismuth subcarbonate is added to this feeding so that the opacity of the media insures a good roentgen contrast.

The child is rotated on its abdomen, lying slightly on the right side so that the ingested media by gravity passes downward to the pylorus. This is an extremely important item as all of these patients swallow a large amount of air increasing the intragastic pressure and ballooning out the

stomach. In a physiological attempt to relieve this pressure, the child attempts to belch. Should the child be lying on its back or on the left side, the feeding is gathered in the cardia covering the cardiac orifice of the stomach. The gas is at the pylorus, mechanically rising to this area which, on account of the posture of the child, lies uppermost. With an effort to belch the cardiac sphincter relaxes and being covered by fluid, the feeding is projected out so that we have what in many cases is termed projectile vomiting. The gas remains in the stomach. When the child is lying on the right side and the gas consequently is in the cardia, the child belches nothing but gas.

A true case of stenosis presents a typical fluoroscopical picture, which has been described in an article by Dr. A. A. Strauss and read before the American Medical Association in June, 1918. In brief, a small quantity of bismuth passes through the pylorus which immediately closes down. Following this, there is a quick rhythmic, whip-lash, or snake-like movement which takes place in the antrum and pylorus. It is characteristic. This quick peculiar movement appears independent of the gastric peristalsis and is pathognomonic. The plates are then taken in that position which the fluoroscope reveals to be the one in which the points of interest can best be observed. Some cases reveal a retro-peristalsis of the stomach and in these cases there may be found a dilated oesophagus, but this associated condition is not always present.

Types

There are three distinct types of stomachs found in this condition. 1. The stomach is dilated and contains considerable fluid, a marked hyper-peristalsis usually appears with the peculiar snake-like lashing of the antrum as described before. The opaque meal in small quantities passes through the pylorus. The pyloric sphincter suddenly contracts, closing the pylorus and preventing the passage of the opaque meal. At the end of two hours a little more can be observed

to have passed into the small intestine, but the amount is very small and is scattered in small masses. At four hours there is a large retention in the stomach consisting of at least one-third of the ingested meal.

2. The opaque meal at no time is observed to pass through the pylorus. At the end of two hours and at four hours, there is a complete retention of the bismuth meal in the stomach. The stomach is more dilated than type No. 1 and there is a larger amount of fluid present. At first there is a marked hyper-peristalsis present again with the peculiar snake-like lashing of the antrum. This labor dies down and becomes very superficial. At four hours there may be no peristalsis at all, or in a number of cases retro-peristalsis was observed.

3. This type is not a well developed case of stenosis. It represents almost the normal infantile gastro-intestinal tract. The stomach is slightly dilated and the peristalsis is deep cutting, almost a hyper-peristalsis. The antrum and pars pylorica cut off well but with the lashing to and fro of the antrum. The pylorus and duodenum fills well and the bismuth mixture passes rapidly into the small intestines. At two hours the stomach is over half empty. At four hours the stomach is entirely empty but with a full four hour motility. The normal gastric motility varies from 2½ to 3½ hours.

With types one and two the indication is for immediate surgical interference. Type three should be placed on expectant treatment until either the pathology progresses sufficiently to place it in class one or two, or until it is determined that the pyloric condition has not advanced. In either event the *x*-ray should be used as a control. It should be noted that in this type, at four hours the stomach is empty. This does not hold true in all cases, for there may be a very slight retention at this time. A retention of one-third or over of the original meal we consider as an operative indication. It is interesting to note that twenty cases of partial stenosis were treated with good results medically.

Total number of infants examined: 132.

Total number of roentgen diagnoses positive: 85.

Total number of roentgen diagnoses negative: 47.

Total number patients operated: 65.

Total operative findings positive: 65.

Resume: The roentgen diagnosis of congenital pyloric stenosis consists of:

1. Dilated stomach.
2. Hyper-peristalsis.
3. Characteristic snake-like movement of antrum and the pylorus.
4. The pylorus may be partially or totally obstructed.
5. One-third or more retention of bismuth meal in four hours.

These patients while under examination should be placed on the right side so that the pylorus is down. This prevents regurgitation. Even a normal infant permitted to lie on the left side may show a retention. These patients were all taken from the clinics of Drs. Abt, Lackner, Hess, Jampolis, Michaels and A. A. Strauss of the Michael Reese Hospital who in every way possible contributed to the success of our roentgen conclusions.

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Abstracts

W. S. Lemon, M. D. Differential Diagnosis of Mediastinal Tumors. *Medical Clinics of North America,* November, 1919, No. 3, p. 635.

Since roentgenology has come to aid the clinician so materially, the following classification of mediastinal affections is offered.

1. Anterior
   (a) Remains of the thymus, or the thymus itself
   (b) Lymph-nodes
   (c) Areolar tissue
2. Middle
   (a) Heart with its arterial and venous trunks
   (b) Trachea and bronchi
   (c) Hilus of lung on each side
3. Posterior
   (a) Lymph nodes
   (b) Esophagus
   (c) Thoracic duct
   (d) Vagus, phrenic and sympathetic nerves

A certain group of symptoms is common to diseases affecting the mediastinum. This is symptoms of pressure on its several structures.

The organs and lesions studied are:

1. Benign neoplasms
2. Malignant neoplasms
3. Abnormally placed organs
   (a) Substernal goiter
   (b) Thymus
4. Hodgkin's Disease
5. Lymphosarcoma
6. Tuberculosis

7. Pathological conditions in the circulatory system
    (a) Aortitis
    (b) Dilatation of aorta from pressure
    (c) Mitral stenosis
    (d) Cardiac hypertrophy, especially with aortic insufficiency
    (e) Pericarditis with effusion
8. Potts' Disease
9. Aneurysm of the thoracic aorta
10. Syphilitic mediastinitis

Benign Neoplasms

Very rare, and of little importance on that account. Dermoids, chondromata and actinomycosis are the types found.

Malignant Neoplasms

Usually single and distinct in outline on roentgen examination. Infiltrating, and grow outward into the chest.

Abnormally Placed Organs

1. Substernal goiter. Not difficult to determine. Roentgen examination reveals a well defined and continuous tumor with the extra-thoracic or cervical.

2. In children, the roentgen shadow of the thymus resembles that of the substernal goiter. It is central, continuous from above downward, and frequently is superimposed on the heart shadow. It is the most frequent mediastinal tumor in infancy.

Hodgkin's Disease

Differentiation not difficult. The clinical history is usually decisive, and the roentgen examination serves to confirm and determine the extent of involvement. The growth is bilateral, extending from the hilus. It is diffuse and feathery in appearance. Frequently fluid is present in the pleural cavity.

Lympho-Sarcoma

It is most common, and often confused with Hodgkin's disease. It is unilateral and distinctly circumscribed.

Metastasis may be present. If the tumor is near the aorta, pulsation may cause difficulties in examination.

Tuberculosis

Seldom difficult because of other evidence of the disease in the chest.

Aortitis

Fluoroscopic and roentgenographic examinations differentiate when clinical signs fail. The aorta is uniformly broadened.

Dilatation of Aorta

Roentgen signs are not given, but said to clear up the diaphragm.

Mitral Stenosis

Roentgen examination not mentioned.

Simple Cardiac Hypertrophy

Roentgen signs show a normal heart magnified. Shape is pearlike, and it fills the costophrenic angle and is uniform over auricular and ventricular areas.

Pericardial Effusion

The roentgen signs of a pyramidal shape of pericardial effusion are invaluable.

Potts Disease

There will be a fusiform symmetrical shadow superimposed on the spine, with destruction of the vertebrae and a narrowing of the costal angles.

Aneurysm

It is the only tumor that erodes and penetrates the chest. A pulsating tumor directly in association with the circulatory mechanism.

Syphilis

Gummata: Large unilateral and well circumscribed, frequently in parenchyma. Decreases in size under treatment.

Mediastinitis

Diffuse substernal shadow, lessening on anti-syphilitic treatment.

Actinomycosis

Fimbricated halo, indicative of inflammatory conditions.

Dr. José Luis Carrera. A Pathological Study of the Lungs in One Hundred and Fifty-two Autopsy Cases of Syphilis. *The American Journal of Syphilis*, January, 1920, Vol. IV, p. 1.

Workers in Roentgen Interpretation should be interested in this original article of a Spanish research student in the laboratory of the University of Michigan, Ann Arbor.

The infrequency of syphilis in the lungs should be kept in mind by the enthusiast. A review of the literature brings out the following interesting information in twenty-one pathological considerations.

1. Frequency of Syphilis of the Lungs

Osler found twelve cases syphilitic lesions in the lungs out of 280 autopsies on syphilitics.

Peterson found eleven cases syphilitic lesions in the lungs out of 88 autopsies on syphilitics.

Stalper found 65 out of 2,995 autopsies on syphilitics.

Hunter, Ellers, and Wires one out of 1000 cases on syphilitics.

These give the lungs the last place in frequency. Clinical men give a much higher frequency and the tendency to make clinical diagnosis is increasing. The discovery depends on the intuition of the observer. The roentgen ray has given more assurance as to diagnosis.

Males have lung findings more frequently than females.

2. Types of Pulmonary Syphilis

Two types of lesions: Gumma and fibrosis. Writers differ in their conceptions. Our knowledge of lung syphilis is incomplete.

3. Spirochetes in Lung Tissue

The spirocheta pallida has been found in congenital syphilis by many workers. In acquired syphilis only a few workers have reported the spirochetes. Finding them in sputum is very questionable.

4. Inception of Pulmonary Syphilis

Writers are in general agreement that the early stages are unknown.

5. Gumma of the Lung

Most descriptions are of the gross appearance. Microscopic descriptions agree on three zones of central degeneration: Acaseation, an intermediate and an outer zone of infiltration.

6. Location of the Gumma

May be anywhere but seldom in the apex, and usually in the right.

7. Gumma in Congenital Syphilis of the Lungs

Described by many writers.

8. Diffuse Syphilitic Pneumonia

Virchow could not differentiate syphilitic pneumonia. Modern writers think they are not different from ordinary pneumonias.

9. Syphilitic Caseous Pneumonia

Most writers deny its existence.

10. Lymphangitis Syphilitica

Of indefinite status.

11. Muscle Cirrhosis—Brown Induration

The so-called carnification of the liver falls in this class. Most writers find that brown induration occurs in syphilitics.

12. Chronic Interstitial Pneumonia—Sclerosis

Syphilis is a disease of chronic evolution and inflammatory reaction with a tendency to the formation of connective tissue. This observation is marked in the lungs and

occurs as an interstitial pneumonia often marking out the lobulated areas.

13. Syphilitic Phthisis

The pathology consists of peri-bronchial fibrosis, empyema, fibroid bands, bronchial dilatation and formation of cavities opening into the bronchi.

14. Bronchial Lesions

Bronchial thickening and bronchiectasis have been noticed by many.

15. Alveolar Epithelium

The alveolar epithelium often appears cuboidal or even low columnar, gland like, but it is not necessarily syphilitic.

16. Syphilitic Lesions in Pulmonary Arteries

The process is mesarteritis and periarteritis as in syphilitic aortitis.

17. Lesions of the Pleura

While pleuritis is observed it is not characteristically syphilitic.

18. Anthracosis and Syphilis of the Lung

Anthracosis seems more frequent and pronounced.

19. Elastic Tissue in Pulmonary Syphilis

Especially in vessel walls has this condition been noted.

20. Syphilis and Tuberculosis

Many cases have been classed tuberculous are syphilitic. Hertz, Virchow and others disagree on the possibility of differentiating the gumma and tubercle. The gumma is considered rich in vascular formation. Groups in masses, scarce in giant cells, infrequent in calcification, preserves the pulmonary tissue.

21. Giant Cells in Syphilis

They occur in both tuberculosis and syphilis, but in tuberculosis are more abundant. There is no difference in the cells in either condition.

11. Results of the Study of the Lungs in 152 Cases of Syphilis, Pathological Laboratory, University of Michigan.

Aside from the relative infrequency of pulmonary gumma little is known of the pathology of syphilis of the lungs.

In twelve cases out of one hundred fifty-two were pathological changes in the lungs undoubtedly syphilitic, as follows:

1.	Gumma of the Lungs	3	Cases
2.	Syphilitic Peribronchitis with Arteritis	2	"
3.	Syphilitic Fibrosis with Arteritis	4	"
4.	Syphilitic Arteritis	3	"
		12	

One of the cases presented gumma in the lung which could be diagnosed macroscopically. It was confirmed by the microscope. The other two cases were diagnosed by the microscope.

Fibrosis is the end of a syphilitic process, but to be positive that syphilis caused the lesion it was necessary to prove it. The typical inflammatory process must accompany it in order to prove the nature.

Eighteen cases showed fibrosis, four were proven to be syphilitic.

Syphilitic lesions of the vessels are typical when found, and may be differentiated from tuberculosis. Tuberculosis takes all the coats of the vessels en masse. Syphilis, one or two.

The coincidence of brown atrophy, the typical heart lung (passive congestion in 100 cases out of 152) illustrates the importance of syphilis as an etiologic factor in cardiac disease.

While pleuritic changes were found they were in no way peculiar to syphilis.

Typical active syphilitic peribronchitis was found in two cases.

A terminal broncho pneumonia or croupous pneumonia occurred in a very high per cent of the cases in connection with an inadequate heart.

Conclusions

The diagnosis of pulmonary syphilis must be made microscopically. The lungs show an incidence of fibrosis comparable to that in other organs in the same cases.

Pulmonary pathologic conditions coincident to myocardial affections occur in a high per cent. Twelve out of one hundred and fifty-two cases showed specific gummatous lesions. Just what per cent of the fibrotic changes are due to syphilis cannot be proven, but it is probable that the lung is subject to the mild inflammatory processes which syphilis causes in other organs and eventually leads to fibrosis.

Dr. F. H. Baetjer. Certain Clinical Aspects of Peptic Ulcer with Special Reference to Roentgen Ray Diagnosis as Observed in 743 Cases. *Johns Hopkins Hospital Bulletin,* August, 1919, Vol. XXIX.

Report shows the close relationship between the clinical and roentgen ray examination.

The 743 cases were divided into three groups:

Group I. Cases proven by operation, 185.

Group II. Cases presenting positive clinical and roentgen findings, 323.

Group III. Cases of doubtful clinical findings and roentgen findings definite, 235.

Group I. 185 Cases

Age, 20 to 40. Sex, 132 males to 52 females.

Normal acidity	32 per cent
Hyperchlorhydria	41 " "
Hypochlorhydria and anacidity	26 " "
Roentgen findings were verified in	79.4 " "
Duodenal ulcers	46 " "
Gastric ulcers	36 " "
Pyloro-duodenal	11.5 " "
Undetermined	5.2 " "

Group II. 323 Cases

Roentgen findings confirmed	84	per cent
Duodenals	43	" "
Gastric ulcers	40	" "
Pyloro-duodenal ulcers	14	" "
Undetermined	3	" "
Pointing to other pathology	15.6	" "

Group III

Duodenal ulcer can always be ruled out. (Practically.) Gastric ulcer cannot always be ruled out.

Signs characteristic of gastric ulcer are those signs pointing to gastric irritation, as delayed emptying, hypermotility, tonic contraction of pylorus, deformity.

Signs characteristic of duodenal ulcer are:

Hypermotility of duodenum and stomach.

Pylorus not spastic, rapid emptying of stomach.

Simple duodenal ulcer empties in fifteen minutes to one hour. No hour glass.

Contractions uniform, pylorus open and bismuth flows freely, duodenum active and shows deformity same place. Two bismuth currents may be seen in cap.

Signs of gastric ulcer:

Primary quick expulsion and then spasticity of the pylorus.

Retention four to six hours.

Filling defect usually present.

Difficult are the complicated cases but investigation often clears up the diagnosis in a positive or a negative manner.

MALLORY. Principles of Pathologic Histology. Textbook, pp. 580.

There are three gross tuberculous lesions of the kidney:

(1) Miliary tuberculosis.
(2) Tuberculous infarcation.
(3) Tuberculous nephritis.

Tuberculous nephritis is the most important form to us since it is chronic in type, and may be the only serious lesion in the body. It is due to the tubercle bacilli gaining

entrance to the pelvis of the kidney and causing a pyelitis. From here they infect the tubules and the intervening lymph vessels and tend to spread toward the cortex, causing necrosis and ulceration which start usually at the apices of the pyramids and gradually erode them. The lesion is analogous to tuberculosis extending along the bronchi of the lung. The process may result in the formation of numerous abscess cavities, some of which may reach the capsule of the kidney, or the whole kidney may be transformed into a succulated cavity filled with cheesy or putty like material.

Manner of Original Infection of Pelvis

(a) By a direct extension of a lesion of hematogenous origin into the pelvis or by bacilli being carried along a tubule from a lesion in the cortex.

(b) Extension of a process from lower down in the genito-urinary tract into the pelvis by way of ureter.

(c) Rarely by direct extension of a tuberculous lesion of an adrenal or other adjoining structure to the kidney, thence to the pelvis.

It has been claimed that tubercle bacilli pass through glomerule and lodge in the collecting tubules of the pyramids where they start an ascending pyonephritis. Evidence to prove this is lacking because it is never found in miliary tuberculosis.

Kelly and Burnham. Diseases of Kidneys, Ureters and Bladder. Text Book, Vol. II, pp. 19.

Most of our knowledge of tuberculous kidney has been elaborated in the past twenty years. The first recorded case is that of Margagni in 1767. This was a kidney made tuberculous from the extension of a contagious process, lymph glands.

Early it was thought that the tuberculous kidney was the end stage of tuberculosis of the genital tract. Later it was found the kidney was occasionally involved alone. Later in one-half the cases only one kidney was involved. Then the surgeons began to remove them boldly.

After this surgery of the kidney made rapid progress. Between 1890 and 1900 modern cystoscopy and catheterization of the ureters was born. This method of examination quickly showed that tuberculous kidney was often unilateral, demonstrated which kidney was involved.

1. Frequency of tuberculous kidney at autopsy without any reference to particular class of subject. 12,688 autopsies collected 603 tuberculous kidneys. 4.7%.

2. Frequency of tuberculous kidney at autopsy with active tuberculosis in other organs. Combining statistics—20.2%.

3. Frequency of kidney involvement in case of miliary tuberculosis. (Practically all.)

4. Relative frequency of miliary and caseo-cavernous form. (Two to one.)

5. The influence of age. Autopsy. In children, 15 per cent. In adults, 4.7 per cent.

6. The proportion of unilateral to bilateral caseo-cavernous tuberculosis.

Every caseo-cavernous begins as unilateral and remains so a long time.

Combining statistics 459, 253 showed only one kidney, *i. e.,* 55.1%. This would mean that even in extreme stages more than one-half unilateral.

In children both kidneys involved (caseo-cavernous type) twice as great chances both are involved.

In bilateral rarely both kidneys involved to the same degree.

In case with no tuberculosis elsewhere in body and bladder not involved. 100% unilateral.

Active tuberculosis in lungs means a greater probability that both kidneys are involved.

7. Frequency of primary renal tuberculosis without evidence of tuberculosis elsewhere in the body. Clinically cannot be shown, must be at autopsy. Only a few in literature as patients do not often die of tuberculous kidney alone. Clinically those that seem primary run 68 to 73 per cent.

Page 39, Figure 278, Photo. Kidney showing disseminated tuberculosis of cortex.

Page 41. Large tuberculous kidney. Photo.

Page 42. Tuberculosis limited to lower pole.

Page 43. Tuberculosis of the left kidney.

Page 44. Massive tuberculosis of the kidney.

Page 46. Massive tuberculosis of kidney and ureter.

Page 49. Tuberculous kidney with cystic transformation of upper pole.

Involvement of ureter in tuberculous kidney. Present to greater or lesser extent in all.

Page 51. Tuberculous kidney with dilated and constricted ureter.

Symptomatology

Chronic. Years. A few heal spontaneously after complete destruction of kidney and closed ureter.

Average symptomatic period three and one-half years.

Classes of Symptoms

1. General manifestations—weight, chills, sweat, fever. 30 per cent robust—40 fair.
2. Pain or tumor in affected kidney on palpation. Tumor never the first complaint, pain the principal in 10 per cent.
3. Bladder disturbance. Frequency and pain in micturition, incontinence of urine, strangury. This is the great and principal symptom. 70 initial—90% alone or in combination with others.

Changes in Urine

Hematuria—25%, small in amount. Turbidity—comes and goes.

Diagnosis

History. Palpation of kidney and ureter. Tuberculin of value. Old hypodermic method best.

Urinary examination: Pus, blood, tuberculosis, smears to rule out smegma, Guinea pig (when no pus it is delicate,

with pus pig is liable to die of pyogenic infection). Two to three who tuberculous lesions develop.

Cystoscopy, etc., tells

1. Bladder involvement.
2. Right or left. (Abnormalities as one kidney, etc.)
3. Typical ureteral orifice. (50%.)
4. Stricture of ureter and dilatation.
5. Functional activity of both.
6. Examination of the other kidney.

X-Ray

1. Outlines.
2. Size.
3. Calcification.
4. Pyelography.
   Outlining cortical abscesses.
   Location cortical abscesses.

The first session of the Louisiana State X-Ray Association, and the sixth session of the Texas Roentgen Ray Society, joint meeting, was held in the Grunewald Hotel, New Orleans, January 3, 1920.

The officers of the Louisiana State X-Ray Association:

Dr. Amedee Granger, President.
Dr. J. A. Gorman, Vice-President.
Dr. S. C. Barrow, Secretary-Treasurer.

Texas Roentgen Ray Society:

Dr. J. W. Torbett, President.
Dr. B. T. Vanzant, Vice-President.
Dr. S. D. Whitten, Secretary-Treasurer.